



## **U.S. ARMY PUBLIC HEALTH COMMAND**

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**Deployment Surveillance Report: Traumatic Brain Injury Identified from  
Hospitalization and Air Evacuation Records – Army, 2004–2009**

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## 14. ABSTRACT

The Army Institute of Public Health conducts injury surveillance for deployed Soldiers to identify and track injury incidence during deployments. For the on-going operations in Iraq (Operation Iraqi Freedom [OIF]) and Afghanistan (Operation Enduring Freedom [OEF]), estimates for the incidence of traumatic brain injury (TBI) have ranged from 10 percent to 40 percent. The purpose of this report is to describe the incidence and causes of TBI that required Army Soldiers to be hospitalized in theater and/or air evacuated from OIF and OEF between Jan 2004 and Dec 2009. From 2004 to 2009, there were 4,182 incident TBI cases (hospitalized and/or air evacuated). The overall annual TBI rate was higher in OEF (66/10,000 person-years) than OIF (45/10,000 person-years). Battle injuries accounted for 69 percent of hospitalized TBIs and 65 percent of air evacuated TBIs. Non-battle injuries (NBI) accounted for the remainder. The leading non-battle causes of TBIs were motor vehicle crashes (42 percent of hospitalized and 30 percent of air evacuated non-battle TBIs) and falls (20 percent of hospitalized and 16 percent of air evacuated of non-battle TBIs, respectively). Recommendations include additional epidemiologic analysis and research to better understand the long-term effects and modifiable risk factors for disability for Soldiers who have had one or more TBI.

## 15. SUBJECT TERMS

Army, TBI, injuries, NBIs, surveillance, OIF, and OEF

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EXECUTIVE SUMMARY  
INJURY PREVENTION REPORT NO. 12-HF-0F7E-09  
DEPLOYMENT SURVEILLANCE REPORT: TRAUMATIC BRAIN INJURY IDENTIFIED  
FROM HOSPITALIZATION AND AIR EVACUATION RECORDS – ARMY, 2004–2009

1. INTRODUCTION AND PURPOSE.

a. On-going military operations in Iraq and Afghanistan have increased awareness of traumatic brain injuries (TBIs), including their short- and long-term impact on the health of Soldiers. According to the Defense and Veterans Brain Injury Center (DVBIC), 74,997 Soldiers (all components; worldwide) were diagnosed with a TBI between 2004 and 2009. According to the DVBIC, yearly TBI incidence increased from 6,205 TBIs in 2004 to a high of 19,680 TBIs in 2008. Estimates for TBI incidence among service members deployed for Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF) have ranged from 10 percent to 40 percent, depending on the population being reported (Hoge, et al., N Engl J Med, 2008; Terrio, et al., J Head Trauma Rehabil, 2009; Colombo, et al., Crit Care Med, 2008).

b. The U.S. Army Public Health Command (USAPHC) conducts population-based injury surveillance for the Army to identify and describe injury incidence, trends, and causes (Army Regulation 40-5, Section 2-19). The USAPHC has a responsibility to conduct TBI surveillance and epidemiologic analysis in the Army Medical Command Traumatic Brain Injury Action Plan (Operation Order #08-39, 9 April 2008).

c. The purpose of this report is to describe the incidence of TBIs that required in-theater hospitalization or air evacuation from OIF and OEF during calendar years 2004 through 2009. It describes the demographics of Soldiers with TBI and summarizes the rate, types, severity, and primary causes of TBI among deployed Soldiers.

2. METHODS.

a. Population. All Army Soldiers (Active Duty, Reserves, and National Guard) deployed in support of OIF or OEF between 1 January 2004 and 31 December 2009 were included in this analysis.

b. Data Sources. TBI cases were identified from in-theater hospitalization records (Standard Inpatient Data Records – Deployment) and air evacuation records (TRANSCOM Regulating and Command & Control Evacuation System (TRAC<sup>2</sup>ES).

c. TBI Case Definition. The DVBIC's standardized set of diagnosis codes for TBI was used to identify Soldiers diagnosed with a TBI. Soldiers with multiple TBI hospitalizations within a 30 day period were considered a single TBI case.

d. Similarly, Soldiers with multiple air evacuations for TBI within 60 days were considered a single TBI case.

e. Analysis. Hospitalized TBIs and air evacuated TBIs were reported and analyzed separately. The total number of Soldiers with TBI (whether hospitalized and/or air evacuated for TBI) was also reported.

### 3. CONCLUSIONS.

a. From 2004 to 2009, 2,959 Soldiers with TBI were hospitalized in U.S. Central Command (CENTCOM) and 1,917 Soldiers with TBI were medically air evacuated from CENTCOM. Of Soldiers hospitalized for TBI, 694 were also air evacuated for the same TBI. After accounting for these 694 Soldiers, there was a total of 4,182 Soldiers with incident TBIs (hospitalized and/or air evacuated).

b. The OIF and OEF rates for incident TBIs were 45 per 10,000 person [p]-years [yrs] and 66 per 10,000 p-yrs, respectively ( $p < .01$ ). The rates for hospitalized TBIs (OIF: 32 per 10,000 p-yrs; OEF: 48 per 10,000 p-yrs) were higher than rates for air evacuated TBIs (OIF: 21 per 10,000 p-yrs; OEF: 31 per 10,000 p-yrs). All OEF TBI rates were higher than OIF rates.

c. Incident TBI rates for OIF were highest in 2007 (92 per 10,000 p-yrs). The higher rate was influenced primarily by a higher rate for battle-related TBIs (64 per 10,000 p-yrs) and to a lesser extent by a higher rate for non-battle-related TBIs (26 per 10,000 p-yrs).

d. Incident TBI rates for OEF increased in 2007 (75 per 10,000 p-yrs) and increased much more sharply in 2009 (115 per 10,000 p-yrs). The higher OEF rate for 2009 was primarily influenced by the much higher rate for battle-related TBIs (91 per 10,000 p-yrs).

e. Battle injuries accounted for 69 percent of hospitalized TBIs and 65 percent of air evacuated TBIs. The leading causes of battle-related TBI included shrapnel/shell fragments (59 percent of the hospitalized battle-related TBIs) and IED/mine/bombs (79 percent of the air evacuated battle-related TBIs).

f. TBIs that were non-battle injuries (that is, injuries that were not caused by hostile or enemy action) comprised 29 percent of hospitalized TBIs and 22 percent of air evacuated TBIs.

g. This is the first known report describing non-battle causes of TBI. The leading causes of hospitalized and/or air evacuated TBIs were motor vehicle crashes (42 percent and 30 percent, respectively), falls (20 percent and 16 percent, respectively), sports/PT (7 percent and 8 percent, respectively), and blunt trauma (5 percent and 17 percent, respectively).

#### 4. RECOMMENDATIONS.

a. Considering that one-quarter of deployment-related TBIs result from non-battle causes, increase TBI surveillance and research efforts to identify potentially modifiable risk factors for leading non-battle causes of TBI (motor vehicle mishaps, falls, sport/exercise, and blunt trauma).

b. Though documentation of TBI in the deployment electronic medical records has greatly improved, increased emphasis is required 1) document TBI incident cases at all levels of deployed medical care and 2) identify and track Soldiers who are at greatest risk for TBI.

c. Conduct surveillance, epidemiologic analysis, and research to identify the incidence of TBI among Soldiers and to evaluate the potential increased risk associated with having a subsequent TBI among Soldiers who have had a prior TBI.

d. Conduct epidemiologic analysis and research to identify the long-term effects and potential modifiable risk factors for disability among Soldiers who have had one or more TBI.

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1. REFERENCES. See Appendix A for references used in this report.

2. PURPOSE. To describe the incidence of traumatic brain injuries (TBIs) that required in-theater hospitalization or air evacuation from Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF) during calendar years 2004 through 2009. This report describes the demographics of Soldiers with TBI and summarizes the rate, types, severity, and primary causes of TBI among deployed Soldiers.

3. AUTHORITY.

a. Under Army Regulation (AR) 40-5, Section 2-19, the U.S. Army Public Health Command (USAPHC), is responsible for Army preventive medicine activities, including review and interpretation of surveillance data, and identification and characterization of health problems as a foundation for injury prevention planning efforts.

b. As indicated in Operation Order #08-39 Army Medical Command Traumatic Brain Injury Action Plan (9 April 2008) paragraph 3c(10)(c), the USAPHC is responsible for conducting TBI surveillance and epidemiological analysis.

4. BACKGROUND.

a. The conflicts in Iraq and Afghanistan have increased awareness of TBIs, including their short- and long-term impact on the health of Soldiers. According to the Defense and Veterans Brain Injury Center (DVBIC), 74,997 Army service members (all components; worldwide) were diagnosed with a TBI between 2004 and 2009, as of 30 December 2011 [1]. Yearly TBI incidence increased from 6,205 TBIs in 2004 to a high of 19,680 TBIs in 2008. Estimates for TBI incidence among Soldiers deployed for OIF and OEF have ranged from 10 percent to 40 percent, depending on the population being reported [2-4]. These injuries have been associated with increased risk of seizures, postconcussion syndrome, deficits in social functioning, and mental health disorders [5]. Though current figures are not available, the financial burden (direct and indirect costs) for the Army is large and increasing. In 2007, Blackman estimated the average lifetime direct medical cost of a TBI to be 2.7 million per injured service member. Based on the annual rates of TBI, an estimated \$1.1 billion per year is spent treating TBIs among service members [6].

b. TBIs result from damage to the brain from a traumatic blow or jolt or from the primary effects of a blast (explosion) [7]. The trauma can result in an open (penetrating) or closed head injury [5]. TBIs are diagnosed on a continuum of severity from mild to moderate to severe. Mild TBIs are the most common among deployed Soldiers and can result in loss of consciousness (LOC) for less than 30 minutes and/or altered mental status around the time of the injury [8]. Individuals with mild TBI usually recover within 3-6 months, but some may have longer lasting neurocognitive or functional effects from the injury. Moderate and severe TBI categories are associated with longer lasting effects that can involve neurocognitive and behavioral functioning [5].

c. Leading causes of TBIs among the U.S. adult population are motor vehicle incidents, falls, and having the head struck by/against an object, which is typical in activities such as sports [8]. In the deployed setting Soldiers are exposed to these same leading causes, in addition to combat-related exposures from instrumentalities of war, such as improvised explosive devices (IEDs) [9]. Research conducted on TBIs during deployment has shown that battle-related causes contribute to more than 70% of TBI diagnoses [2, 3, 10]. Galarneau, using the Navy-Marine Corps Combat Trauma Registry, identified 115 service members with a TBI within a 7-month period; 93% of these injuries were attributed to enemy-related causes [10].

## 5. METHODS.

a. Population. All Army Soldiers (Active Duty, Reserves, and National Guard) deployed in support of OIF or OEF who were hospitalized in the U.S. Central Command (CENTCOM) area of responsibility (AOR) or air evacuated from CENTCOM with a diagnosis of traumatic brain injury between 1 January 2004 and 31 December 2009 were included in this analysis. The Joint Chiefs of Staff, Manpower and Personnel Directorate provided unclassified data on the number of deployed persons per year supporting OIF and OEF. The Defense Manpower Data Center provided demographic information on this population.

b. Data Sources. Two sources of electronic records were used to identify Soldiers who were hospitalized in the CENTCOM AOR or air medical evacuated from CENTCOM with a traumatic brain injury. The specific data sources were the Standard Inpatient Data Records (SIDR) and the Transportation Command (TRANSCOM) Regulating and Command & Control Evacuation System (TRAC<sup>2</sup>ES), respectively. Data from both sources were accessed in November 2011.

(1) The SIDR hospitalization records for Army Soldiers hospitalized in the CENTCOM AOR were obtained from Patient Administration Systems and Biostatistics Activity (PASBA), Program Analysis and Evaluation Directorate, Office of the Surgeon

General, Ft. Sam Houston Texas. These records included patient demographics, hospitalization dates, coded medical diagnoses (up to eight diagnosis codes from the International Classification of Diseases, 9<sup>th</sup> Edition, Clinical Modification [ICD-9-CM]), and coded causes of injury.

(2) TRAC<sup>2</sup>ES air evacuation records were obtained from the U.S. Transportation Command (TRANSCOM) for Soldiers who were air evacuated from CENTCOM to receive higher level medical care at treatment facilities in Germany or the U.S. The primary purpose of these air evacuation records was to document request for and coordination of transportation of patients between medical facilities. Each time a patient was evacuated to a higher level of care, a TRAC<sup>2</sup>ES record was created, resulting in multiple records for patients with multiple air evacuation movements. Only air evacuation movements that originated in the CENTCOM AOR with a destination outside of CENTCOM (that is Germany or the United States) were included in this analysis. Air evacuation records included patient demographics, air evacuations dates, originating treatment facility and theater, destination treatment facility and theater, coded medical diagnosis codes (up to three diagnosis codes from the ICD-9-CM), and a narrative patient history.

c. Case Definition for Traumatic Brain Injury.

(1) The DVBIC's standardized set of ICD-9-CM codes for TBI was used to identify TBIs among all hospitalized and all air evacuated Soldiers [12]. See Appendix B for DVBIC's standardized set of ICD-9-CM codes used to identify TBI cases.

(a) The DVBIC convened a workgroup of civilian and military experts (TBI Surveillance Working Group) to select a standardized subset of ICD-9-CM diagnosis codes that would be used within the Department of Defense (DOD) and Department of Veterans Affairs to identify and classify TBI cases. The DVBIC codes also included the DOD extender codes for personal history of TBI (V15.52\_x; V15.5\_x; or V15.59\_x) [7, 11].

(b) The DVBIC TBI ICD-9-CM diagnosis codes were classified into five severity categories (that is, penetrating, mild, moderate, severe, and unclassified). Appendix C lists the ICD-9-CM codes that were selected by the DVBIC workgroup and shows the severity category assigned to each code [11, 12].

(c) The Armed Forces Health Surveillance Center (AFHSC) classified the DVBIC TBI codes into three functional categories (that is, TBI, postconcussion syndrome, and unspecified TBI). Specific head and/or neck injuries fall under the functional classification of TBI (ICD-9-CM codes: 800, 801, 803, 804, 850-854, and

950.1-950.3). Postconcussion syndrome includes current effects of a previous injury (ICD-9-CM code: 310.2). The unspecified TBI functional classification includes head injuries which were unspecified by time, type, and clinical effects (ICD-9-CM code 959.01) [11].

(d) A small subset of the DVBIC ICD-9-CM codes is not included in the TBI definition accepted by the Centers for Disease Control & Prevention (CDC) and widely used throughout the United States. In the Barell Matrix, which is advocated by the CDC, traumatic injuries (ICD-9-CM codes 800-995) are classified by body region and nature of injury [13]. In this matrix, TBIs are displayed in the first three rows; representing three mutually exclusive severity levels (that is, Type 1, Type 2, and Type 3, in decreasing order of severity). Head injuries are classified as Type 1 TBI when there is an intracranial injury or moderate/prolonged LOC (>1 hours), or when there is injury to the optic nerve. Type 2 TBI includes injuries with no evidence of intracranial injury, and a LOC of less than one hour or of unknown duration. The least severe TBI classification, Type 3, includes injuries with no evidence of intracranial injury and no LOC. The following DVBIC codes are not included in the CDC's categorization of TBIs represented in the Barell Matrix: 310.2 (postconcussion syndrome), 907.0 (late effect of injury to the cranial nerve), 959.01 (head injury, unspecified), and DOD extender codes (V15.52\_x, V15.5\_x, and V15.59\_x) [13].

(2) The TBIs reported in this analysis were identified by searching all available ICD-9-CM codes for the DVBIC TBI ICD-9-CM diagnosis codes (an air evacuation record could have up to three codes and a hospitalization record could have up to eight codes). If a record had more than one TBI ICD-9-CM code, the first listed TBI code was used in this analysis to ensure that each case was only counted once.

(3) For this analysis, a TBI case was defined as a Soldier (Active Duty, Reserve, or National Guard) who was hospitalized in CENTCOM or air evacuated from CENTCOM with a TBI (DVBIC ICD-9-CM diagnosis code). Since Soldiers could be hospitalized in CENTCOM for TBI more than one time between 2004 and 2009, a 30-day exclusion criterion was used to define a hospitalized TBI case for this analysis. If a Soldier was hospitalized in CENTCOM one or more times for TBI within a 30 day period, the Soldier was counted as one hospitalized TBI case. However, if the Soldier's subsequent in-theater hospitalization(s) for TBI was more than 30 days after being discharged for TBI, the Soldier was counted as having multiple hospitalized TBI incidents.

(4) Similarly, since Soldiers could be air evacuated from CENTCOM for a TBI more than one time between 2004 and 2009, an exclusion rule was used to define an air evacuated TBI case for this analysis. If a Soldier had one or more air evacuations

from CENTCOM for TBI within a 60 day period, the Soldier was counted as one air evacuated TBI case. However, if the Soldier's subsequent air evacuation from CENTCOM for TBI was more than 60 days after a prior air evacuation from CENTCOM for TBI, the Soldier was counted as multiple air evacuated TBI cases.

d. Cause of Injury Coding.

(1) Injury hospitalization records included a coded cause of injury. The coding scheme used by PASBA coders was developed by the North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) No. 2050, 5<sup>th</sup> Edition (Military Agency for Standardization, 1989) [14]. The STANAG injury code is a four-digit code that describes the intent/situation of the injury incident, injury cause, and where the injury occurred. The first digit is the trauma code indicating the intent/situation of the injury (for example, battle injury, intentional non-battle injury, or unintentional non-battle injury). The second through fourth digits indicate the cause of injury, including the specific causative agent and in some cases where the injury occurred.

(2) Air evacuation records did not include a coded trauma type or cause of injury. Trained coders at the USAPHC reviewed the narrative patient histories for all Soldiers air evacuated for treatment of an injury, including TBI, to identify and code the cause of injury. The STANAG coding scheme that was used by PASBA for the hospitalization records was also used by the coders at USAPHC to code trauma types and causes of injury in the air evacuation records.

(3) The STANAG trauma codes were used to classify TBI injuries by their casualty type (that is, battle injury [BI], non-battle injury [NBI], and unknown), while the STANAG cause codes identified the cause of the injury as described in the narrative patient history in the air evacuation records. The STANAG injury codes were not assigned to TBI cases with insufficient information in the narrative patient history regarding the casualty type or cause of the injury. These cases were assigned to the 'unknown' classification for casualty type.

e. Data Analysis.

(1) The results of this analysis present the TBI findings from each injury record source, SIDR (hospitalizations) and TRAC<sup>2</sup>ES (air evacuations), separately, and also describes the incident TBI cases. While identifying the overall number of incident TBI cases is important, presenting the incidence of hospitalized TBIs and air evacuated TBIs separately provides a clear depiction of the burden placed on medical treatment facilities in CENTCOM and on the medical air evacuation system.

(2) Descriptive statistics were used to describe the 1) demographics and casualty type for all Soldiers who were hospitalized or air evacuated and for those Soldiers who were diagnosed with a TBI, 2) incidence and trends for hospitalized TBIs, air evacuated TBIs, and incident TBIs, 3) TBI severity using the DVBIC categories, 4) TBI functional categories using the AFHSC classification scheme, and 5) causes of TBI.

(3) The Chi-square test of proportions was used to compare the demographic distributions of all hospitalized casualties, hospitalized casualties with TBIs, and all deployed Soldiers. This test was also used to compare demographic distributions of all air evacuated casualties to Soldiers with TBI and to all deployed Soldiers

(4) Rates for hospitalized TBIs and air evacuated TBIs were calculated using the respective number of hospitalized, air evacuated, or incident TBIs in each calendar year divided by the deployed Soldier person (p)-years for that same year, and then multiplied by 10,000 (number of TBIs per 10,000 deployed p-years).

(5) TBIs and all other traumatic injuries (ICD-9-CM codes 800-995) among hospitalized and air evacuated Soldiers were categorized by nature of injury and body region using a modified Barell Matrix that was developed specifically for this report (Appendix D). As in the standard Barell Matrix, TBIs were represented in the first three rows. The matrix was modified to include the DVBIC TBI ICD-9-CM codes that were not in the standard Barell Matrix. To incorporate these additional DVBIC codes, a 4<sup>th</sup> row was inserted into the Barell Matrix labeled "Additional DVBIC TBIs". The DVBIC ICD-9-CM code 959.01 is included in column M of the modified matrix, "Unspecified Injury Type"; 907.0 is relocated to column N, "System-wide & Late effects"; and 310.2, is presented in additional column, "postconcussion," to the far right of the modified matrix (column O). The extender codes (V-codes) used by DVBIC to identify TBI cases were not added to the modified Barell Matrix since none of these codes were the primary ICD-9-CM code identifying a TBI case. Appendix D lists the ICD-9-CM codes within each respective category of this modified Barell Matrix.

(6) To populate the modified Barell Matrix for Soldiers with in-theater hospitalizations and air evacuations from CENTCOM, one traumatic injury (ICD-9-CM codes 800-995) was identified per hospitalized or air evacuated Soldier. For all cases with a DVBIC TBI ICD-9-CM diagnosis code, the first available TBI diagnosis code was used in the matrix. The remaining non-TBI injuries (one injury per Soldier) were included in the modified Barell Matrix using the first traumatic injury (ICD-9-CM codes 800-995) diagnosis code reported in the record. Non-TBI cases without a traumatic injury were not included in the modified Barell Matrices presented in this report.

## 6. RESULTS.

### a. Description of Traumatic Brain Injuries.

Table 1. Casualty Type and Incidence of Hospitalized and Air Evacuated Traumatic Brain Injuries among Deployed Soldiers, 2004-2009<sup>1, 2</sup>

Casualty Type	Hospitalized				Air Evacuated			
	Total		TBI Cases		Total		TBI Cases	
	n	%	n	%	n	%	n	%
Injury								
- Battle Injury	9,195	25.4	2,055	69.4	7,778	19.0	1,248	65.1
- Non-Battle Injury	6,541	18.0	849	28.6	14,196	34.6	420	21.9
- Unknown	-	-	55	1.9	-	-	249	13.0
Disease	20,523	56.6	-	-	19,046	46.4	-	-
Total	36,259	100.0	2,959	100.0	41,020	100.0	1,917	100.0

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (OIF and OEF).

<sup>2</sup> Traumatic brain injury was identified from any-listed injury diagnosis in the hospitalization or air evacuation record.

- Table 1 presents the total number of hospitalized and air evacuated Soldiers during calendar years 2004 through 2009, and the number of TBI cases that were hospitalized and air evacuated by casualty type.
- Of the 36,259 Soldiers who were hospitalized in-theater, 2,959 (8.2 percent) had a TBI. Of the 41,020 who were air evacuated, 1,917 (4.7 percent) had a TBI.
- Nearly two percent of the hospitalized TBI cases and 13.0 percent of the air evacuated TBI cases did not have a recorded cause of injury in their records and were, therefore, categorized as 'Unknown' in Table 1.
- The battle injury and non-battle injury distributions for hospitalized and air evacuated TBIs were different compared to non-TBI hospitalized and air evacuated injuries.

Table 2. Demographic Characteristics of Soldiers Hospitalized for Traumatic Brain Injury Compared to the Demographics of All Hospitalized Soldiers and All Deployed Soldiers, 2004-2009<sup>1</sup>

Demographics	TBI		All Hospitalized			All Deployed		
Rank	n	%	n	%	p-value <sup>2</sup>	n	%	p-value <sup>3</sup>
Junior Enlisted (E1-E3)	617	20.9	6,433	17.7	<.01	227,725	18.9	<.01
NCO (E4-E6)	2,017	68.2	23,597	65.1	<.01	688,164	57.1	<.01
Senior NCO (E7-E9)	130	4.4	2,831	7.8	<.01	105,250	8.7	<.01
Company Grade Officer (O1-O3)	141	4.8	1,762	4.9	0.24	91,514	7.6	<.01
Senior Officer (O4+)	31	1.0	1,051	2.9	<.01	62,276	5.2	<.01
Warrant Officer (WO1-WO4)	16	0.5	545	1.5	<.01	31,055	2.6	<.01
Unknown	7	0.2	40	0.1	-	4	0.0	-
<b>Age Group (years)</b>								
17-19	144	4.9	1,501	4.1	0.05	61,294	5.1	0.61
20-29	2,036	68.8	21,132	58.3	<.01	670,147	55.6	<.01
30-39	624	21.1	8,428	23.2	<.01	315,275	26.1	<.01
40-49	133	4.5	4,089	11.3	<.01	133,574	11.1	<.01
50+	13	0.4	1,079	3.0	<.01	25,577	2.1	<.01
Unknown	9	0.3	30	0.1	-	121	0.0	-
<b>Gender</b>								
Male	2,884	97.5	32,122	88.6	<.01	1,086,205	90.1	<.01
Female	75	2.5	4,137	11.4	<.01	119,765	9.9	<.01
Unknown	0	0.0	0	0.0	-	18	0.0	-
<b>Total</b>	<b>2,959</b>		<b>36,259</b>			<b>1,205,988</b>		

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (OIF and OEF).

<sup>2</sup> The p-value compares hospitalized TBI cases to all hospitalized non-TBI cases among Soldiers in CENTCOM.

<sup>3</sup> The p-value compares hospitalized TBI cases to all Soldiers deployed for OIF and OEF between 2004 and 2009.

- Table 2 compares the demographics of Soldiers who were hospitalized for TBI to the demographics of all hospitalized Soldiers and all deployed Soldiers (2004 to 2009).
- The Soldiers hospitalized for a TBI tended to be E4-E6 rank (68.2 percent), aged 20 to 29 years (68.8 percent), and male (97.5 percent).
- When the demographics of Soldiers hospitalized for TBI were compared to the demographics of hospitalized Soldiers who did not have a TBI, more Soldiers with a TBI were E4-E6 rank ( $p<.01$ ), aged 20 to 29 years ( $p<.01$ ), and male ( $p<.01$ ).

- The same general patterns were noted when comparing the demographic distributions of Soldiers hospitalized for TBI to those for all Soldiers deployed from 2004 to 2009. Again E4-E6 ranked Soldiers ( $p<.01$ ), aged 20-29 ( $p<.01$ ), and male Soldiers ( $p<.01$ ) made up a larger proportion of TBI cases when compared to all deployed Soldiers.

Table 3. Demographic Characteristics of Soldiers Air Evacuated for Traumatic Brain Injury Compared to the Demographics of All Air Evacuated Soldiers and All Deployed Soldiers, 2004-2009<sup>1</sup>

Demographics	TBI		All Air Evacuated			All Deployed		
Rank	n	%	n	%	p-value <sup>2</sup>	n	%	p-value <sup>3</sup>
Junior Enlisted (E1-E3)	415	21.6	6,790	16.6	.01	227,725	18.9	<.01
NCO (E4-E6)	1280	66.8	26,378	64.3	<.01	688,164	57.1	<.01
Senior NCO (E7-E9)	94	4.9	3,262	8.0	0.17	105,250	8.7	<.01
Company Grade Officer (O1-O3)	74	3.9	1,901	4.6	<.01	91,514	7.6	<.01
Senior Officer (O4+)	26	1.4	1240	3.0	<.01	62,276	5.2	<.01
Warrant Officer (WO1-WO4)	10	0.5	756	1.8	<.01	31,055	2.6	<.01
Unknown	18	0.9	693	1.7	-	4	0.0	-
<b>Age Group</b>								
17-19	77	4.0	1,205	2.9	0.02	61,294	5.1	0.02
20-29	1,227	64.0	21,743	53.0	<.01	670,147	55.6	<.01
30-39	460	24.0	10,432	25.4	0.08	315,275	26.1	0.03
40-49	115	6.0	5,373	13.1	<.01	133,574	11.1	<.01
50+	16	0.8	1,521	3.8	<.01	25,577	2.1	<.01
Unknown	22	1.1	746	1.8	.01	121	0.0	<.01
<b>Gender</b>								
Male	1,853	96.7	36,042	87.9	<.01	1,086,205	90.1	<.01
Female	62	3.2	4,841	11.8	<.01	119,765	9.9	<.01
Unknown	2	0.1	137	0.3	0.04	18	0.0	<.01
<b>Total</b>	<b>1,917</b>		<b>41,020</b>			<b>1,205,988</b>		

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (OIF and OEF).

<sup>2</sup> The p-value compares TBI cases air evacuated from CENTCOM to all non-TBI cases air evacuated from CENTCOM.

<sup>3</sup> The p-value compares TBI cases air evacuated from CENTCOM to all Soldiers deployed for OIF and OEF between 2004 and 2009.

- Table 3 compares the demographics of Soldiers who were air evacuated for TBI to the demographics of all air evacuated Soldiers and all deployed Soldiers (2004 to 2009).
- The majority of Soldiers air evacuated for TBI were E4-E6 rank (66.8 percent), aged 20 to 29 years (64.0 percent), and male (96.7 percent).

- Distributions of rank, age, and gender for Soldiers air evacuated for TBI were statistically different compared to the distributions for all air evacuated Soldiers who did not have a TBI. A greater proportion Soldiers air evacuated for TBI were E4-E6 rank ( $p<.01$ ), aged 20-29 ( $p<.01$ ), and male ( $p<.01$ ).
- Comparing Soldiers air evacuated for TBI to all deployed Soldiers, the same differences were noted. More Soldiers with a TBI were E4-E6 rank ( $p<.01$ ), aged 20 to 29 years ( $p<.01$ ), and male ( $p<.01$ ).

Table 4. Description of Hospitalized and Air Evacuated Traumatic Brain Injuries, and of All Incident Traumatic Brain Injuries<sup>1</sup>, 2004-2009<sup>1</sup>

TBI Category	Hospitalized TBIs		Air Evacuated TBIs		Incident TBIs <sup>2</sup>	
	(n= 2,959)	%	(n=1,917)	%	(n=4,182)	%
<b>Casualty Type</b>						
- Battle Injury	2,055	69.4	1,248	65.1	2,791	66.7
- Non-Battle Injury	849	28.7	420	21.9	1,105	26.5
- Unknown	55	1.9	249	13.0	286	6.8
<b>Severity Category<sup>3</sup></b>						
- Mild	1,934	65.4	1,527	79.7	2,962	70.8
- Moderate	410	13.9	353	18.4	596	14.2
- Severe	61	2.1	4	0.2	63	1.5
- Penetrating	552	18.7	31	1.6	558	13.4
- Unspecified	2	0.1	2	0.1	3	0.1
<b>Functional Category<sup>4</sup></b>						
- TBI	2,686	90.8	1,102	57.5	3,338	79.8
- Postconcussion	80	2.7	641	33.4	590	14.2
- Unspecified TBI	193	6.5	174	9.1	254	6.0

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (OIF and OEF).

<sup>2</sup> Accounts for overlap in traumatic brain injury cases: 694 TBIs were hospitalized in-theater and then air evacuated.

<sup>3</sup> Severity categories were developed by the Defense Veteran Brain Injury Center (Appendix C).

<sup>4</sup> Functional categories were developed by the Armed Forces Health Surveillance Center. Refer to paragraph 5b(2)(c) for the description of these codes.

- Table 4 categorizes the hospitalized (n=2,959 cases), air evacuated (n=1,917 cases), and incident TBIs (4,182 cases) according to their casualty type, severity category, and functional category.
- Of the TBI cases that were hospitalized in-theater (n=2,959), 694 (694/1,917; 36.2 percent) were also air evacuated for a TBI that was documented in the air evacuation record.
- Accounting for this overlap in hospitalized and air evacuated TBI cases (n=694), there were a total of 4,182 incident TBI cases.

Casualty Type:

- Two-thirds (66.7 percent) of the incident TBI cases were battle injuries. Battle injuries accounted for 69.4 percent of hospitalized TBIs and 65.1 percent of air evacuated TBIs. Non-battle injuries accounted for one-quarter (26.5 percent) of the incident TBI cases.
- Overall, 6.8 percent of the incident TBI cases did not have a recorded cause of injury and were categorized as 'Unknown'.

Severity Category (described in paragraph 5d(1)(b) and Appendix C):

- Overall, 70.8 percent of the incident TBIs were categorized as mild injuries. But the proportion of mild TBIs among all air evacuated TBIs (79.7 percent) was larger than the proportion of mild TBIs among all hospitalized TBIs (65.4 percent).
- Penetrating TBIs accounted for 13.4 percent of the incident TBIs (n=558). Most of these (n=552) TBIs had been hospitalized.

Functional Category (described in paragraph 5d(1)(c)):

- Overall, 79.8 percent of the incident TBIs were categorized as "TBI" according to the AFHSC's functional categorization scheme. A much larger proportion of the hospitalized TBIs (90.8 percent) compared to air evacuated TBIs (57.5 percent), was categorized as functional TBIs.
- Overall, 14.2 percent (n=590) of the incident TBI cases were categorized as postconcussion syndrome. Only 2.7 percent of the hospitalized TBIs were categorized as postconcussion but 33.4 percent of the air evacuated TBI cases were postconcussion.

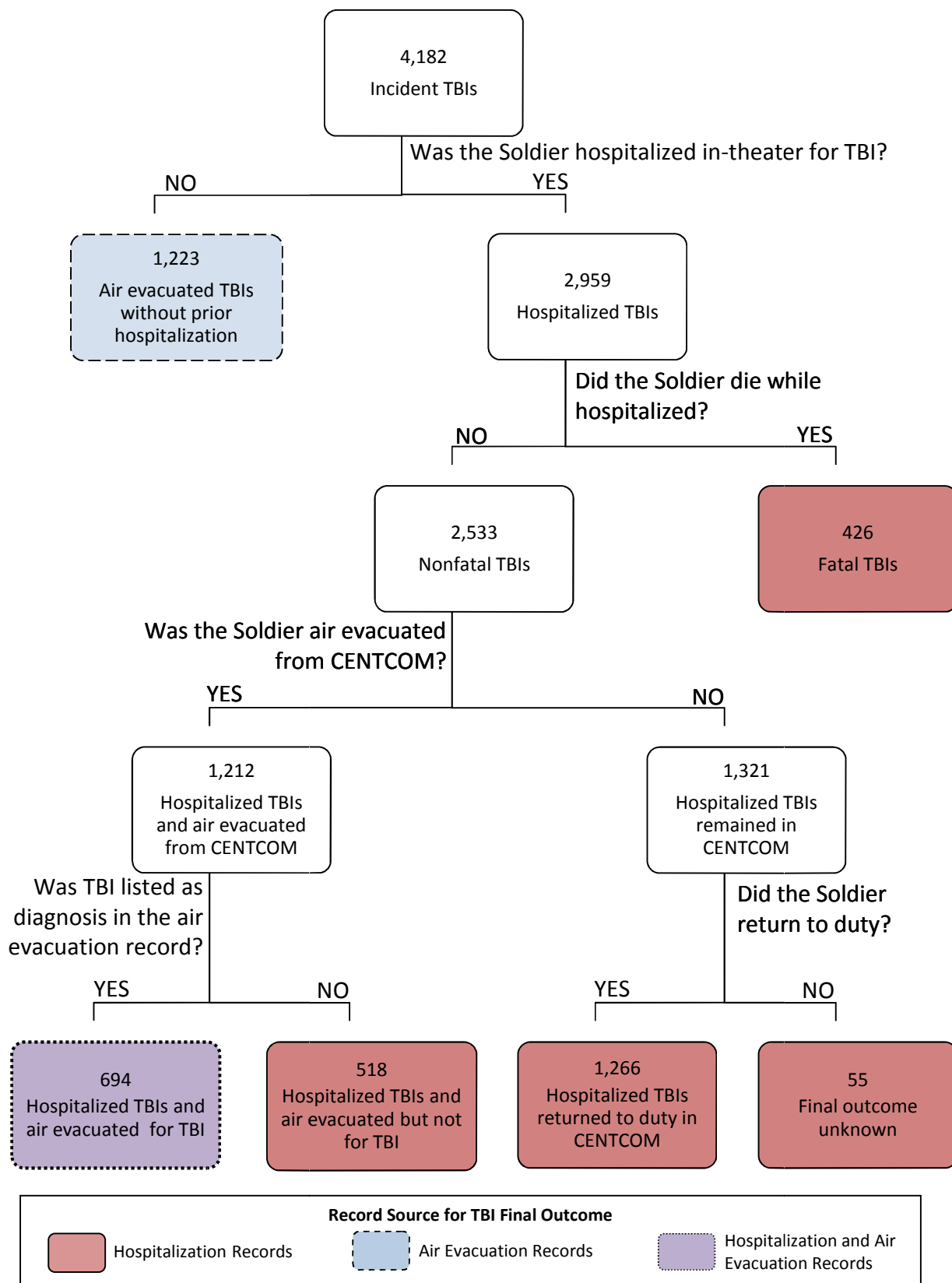


Figure 1. Data Source and Disposition for Incident Traumatic Brain Injury Cases, 2004-2009

- Figure 1 presents the record source used to identify the TBI cases and the disposition (outcome) for the incident TBI cases for calendar years 2004 through 2009.
- As presented in Table 4, there were 4,182 incident TBI cases identified from the in-theater hospitalization and/or medical air evacuation records. In Figure 1, the shaded blocks represent the record source for each of the final dispositions among the incident TBI cases. Blocks shaded in red (solid border) represent TBI cases identified only from the in-theater hospitalization records; blue (dashed border) represents TBI cases identified only from the air evacuation records; and the purple shaded block (dotted border) represents TBI cases that were identified in both hospitalization and out-of-theater air evacuation records.
- Of the 4,182 TBI cases, 29.2 percent (n=1,223) were air evacuated from CENTCOM without a prior hospitalization for the injury.
- A majority of TBI cases (n=2,959; 70.8 percent) were hospitalized for their injury.
- In- theater hospitalization records provided a disposition for each TBI case allowing outcomes to be identified. According to these records, 14.4 percent of the hospitalized TBIs were fatal, 44.6 percent remained in-theater after their hospitalization, and 41.0 percent were air evacuated from theater.
- Of the 426 TBIs who died before or during hospitalization (recorded in hospitalization record), 3 Soldiers were killed in action, 218 were dead on arrival, 141 died in the emergency room, and 64 Soldiers died during hospitalization.
- Of the 1,212 Soldiers who were air evacuated from theater after being hospitalized for a TBI, 694 (57.3 percent) also had a TBI diagnosis documented in their air evacuation records (identified as TBI cases in the hospitalization and air evacuation records). But 518 (42.7 percent) hospitalized TBI cases did not have a TBI diagnosis in their air evacuation record, as other injury-related diagnoses were recorded in these records. These 518 cases would not have been identified as TBI cases based solely on their air evacuation records.
- Of the 1,321 TBI cases that remained in-theater following hospitalization for a TBI, 1,266 (95.8 percent) were able to return to duty in CENTCOM. The final disposition of 55 hospitalized TBIs was unknown (that is, not recorded in the hospitalization records).

Table 5. Disposition and Injury Categories for Hospitalized and Air Evacuated Traumatic Brain Injuries, 2004-2009<sup>1</sup>

TBI Category	SOURCES AND OUTCOMES OF TBI CASES (n=4,182)												Row Totals	
			CASE WAS IDENTIFIED IN HOSPITALIZATION RECORDS (n=2,959)											
			CASE WAS IDENTIFIED IN AIR EVACUATION RECORDS (n=1,917)											
	Air Evacuated TBIs without prior hospitalization	Hospitalized TBIs, air evacuated with a TBI <sup>2</sup>	Hospitalized TBIs, air evacuated <u>without</u> a TBI diagnosis	Fatal TBIs during hospitalization <sup>3</sup>	Hospitalized TBIs discharged and returned to duty	Hospitalized TBIs with unknown disposition								
	n=1,223	%	n=694	%	n=518	%	n=426	%	n=1,266	%	n=55	%	n=4,182	%
Casualty Type														
- Battle Injury	736	60.2	485	69.9	394	76.1	373	87.6	765	60.4	38	69.1	2,791	66.7
- Non-Battle Injury	256	20.9	185	26.7	118	22.8	53	12.4	479	37.8	14	25.5	1,105	26.5
- Unknown	231	18.9	24	3.5	6	1.2	0	0.0	22	1.7	3	5.5	286	6.8
Severity Category														
- Mild	1028	84.1	416	59.9	326	62.9	13	3.1	1,137	89.8	42	76.4	2,962	70.8
- Moderate	186	15.2	148	21.3	124	23.9	7	1.6	125	9.9	6	10.9	596	14.3
- Severe	2	0.2	1	0.1	3	0.6	57	13.4	0	0.0	0	0.0	63	1.5
- Penetrating	6	0.5	128	18.4	65	12.5	349	81.9	3	0.2	7	12.7	558	13.3
- Unspecified	1	0.1	1	0.1	0	0.0	0	0.0	1	0.1	0	0.0	3	0.1
Functional Category														
- TBI	652	53.3	628	90.5	480	92.7	414	97.2	1,115	88.1	49	89.1	3,338	79.8
- Postconcussion	510	41.7	35	5.0	8	1.5	0	0.0	34	2.7	3	5.5	590	14.1
- Unspecified TBI	61	5.0	31	4.5	30	5.8	12	2.8	117	9.2	3	5.5	254	6.1

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (OIF and OEF).<sup>2</sup> Represents overlap in traumatic brain injury cases among hospitalization and air evacuation records.<sup>3</sup> Fatal TBIs included: killed in action (n=3); dead on arrival (n=218); died in the emergency room (n=141); and died during hospitalization (n= 64).

- Table 5 combines data on the TBI categories from Table 4 and data on TBI outcomes from Figure 1 to summarize the theater-based outcome for the incident TBI cases (n=4,182) according to the TBI categories.

#### Casualty Category:

- Overall, 66.7 percent of the incident TBIs were battle injuries and 26.5 percent were non-battle injuries (Table 5).
- There were higher proportions of battle injury among the fatal TBIs (87.6 percent) and the TBI cases that were hospitalized and subsequently air evacuated without a TBI diagnosis being recorded in air evacuation records (76.1 percent). For these latter TBI cases, other injuries that required greater medical attention during the air evacuation movement were recorded in air evacuation records.

#### Severity Category:

- Hospitalization and air evacuation records showed that mild and moderate TBIs were the most frequent severity categories among all TBI outcomes except for fatal TBIs and those with an unknown disposition. The leading severity categories for the fatal TBIs were penetrating (81.9 percent) and severe TBIs (13.4 percent). The leading categories for those with an unknown disposition were mild (76.4 percent) and penetrating (12.7 percent).
- Among the 426 fatal TBIs, 349 were penetrating TBIs (81.9%), 57 were severe TBIs (13.4 percent), 7 were moderate TBI (1.6 percent), and 13 were classified as mild TBI (3.1 percent). The TBI severity of those who died was substantially greater than Soldiers who survived a TBI. The Soldiers who died having mild and moderate TBIs most likely had other more serious injuries that resulted in their death.

#### Functional Category:

- As shown in Table 5, 79.8 percent of the incident TBIs had a functional classification of "TBI". For each of the TBI outcomes in Table 5 except "air evacuated without prior hospitalization," the proportion of TBI cases with a "TBI" functional classification ranged from 88.1 percent to 97.2 percent.
- Only 53.3 percent of the TBI cases that were "air evacuated without prior hospitalization" were classified as functional "TBI."

- Of the TBI cases that were “air evacuated without prior hospitalization”, 41.7 percent were classified as “postconcussion.” For each of the other TBI outcomes in Table 5, 5.5 percent or less of the TBIs had this functional classification.

Table 6. Distribution of Hospitalized Traumatic Battle Injuries by Body Region and Nature of Injury, 2004–2009<sup>1-3</sup>

Body Region of Injury			Fracture	Dislocation	Sprains/ Strains	Internal	Open Wound	Amputations	Blood Vessel	Contusion/ Superficial	Crush	Burns	Nerves	Unspeci- fied	System- wide & late effects	Post- Concussion	Total	Percent	Percent by Body Region
Traumatic Brain Injury (n=2,955)	Head: Traumatic Brain Injury Severity Type	Type 1 TBI	510	-	-	327	-	-	-	-	-	-	0	-	-	-	837	9.2	22.6
		Type 2 TBI	108	-	-	952	-	-	-	-	-	-	-	-	-	-	1060	11.7	
		Type 3 TBI	49	-	-	-	-	-	-	-	-	-	-	-	-	-	49	0.5	
		Additional DVBIC codes	-	-	-	-	-	-	-	-	-	-	-	98	0	11	109	1.2	
Non-Traumatic Brain Injury (n=7,018)	Other Head, Face, Neck	Other head	-	-	-	-	62	-	-	-	-	4	3	-	-	-	69	0.8	13.7
		Face	166	0	0	-	376	-	-	-	-	30	-	-	-	-	572	6.3	
		Eye	-	-	-	-	149	-	-	34	-	8	2	-	-	-	193	2.1	
		Neck	4	-	0	-	195	-	-	-	0	7	0	-	-	-	206	2.3	
		Head, Face, Neck Unspec.	-	-	-	-	-	-	32	30	0	139	0	3	-	-	204	2.2	
	Spinal Cord (SCI)	Cervical SCI	9	-	-	2	-	-	-	-	-	-	-	-	-	-	11	0.1	0.5
		Thoracic/Dorsal SCI	12	-	-	1	-	-	-	-	-	-	-	-	-	-	13	0.1	
		Lumbar SCI	9	-	-	1	-	-	-	-	-	-	-	-	-	-	10	0.1	
		Sacrum Coccyx SCI	1	-	-	0	-	-	-	-	-	-	-	-	-	-	1	0.0	
		Spine, Back Unspec. SCI	3	-	-	3	-	-	-	-	-	-	-	-	-	-	6	0.1	
	Vertebral Column (VCI)	Cervical VCI	16	0	16	-	-	-	-	-	-	-	-	-	-	-	32	0.4	1.3
		Thoracic/Dorsal VCI	19	0	0	-	-	-	-	-	-	-	-	-	-	-	19	0.2	
		Lumbar VCI	41	2	6	-	-	-	-	-	-	-	-	-	-	-	49	0.5	
		Sacrum Coccyx VCI	12	0	0	-	-	-	-	-	-	-	-	-	-	-	12	0.1	
		Spine, Back Unspec. VCI	2	0	-	-	-	-	-	-	-	-	-	-	-	-	2	0.0	
	Torso	Chest (thorax)	16	0	0	252	58	-	19	17	2	6	0	-	-	-	370	4.1	12.6
		Abdomen	-	-	-	360	74	-	6	6	-	1	1	-	-	-	448	4.9	
		Pelvis, Urogenital	41	0	4	25	141	-	7	1	0	1	0	-	-	-	220	2.4	
		Trunk	1	-	-	-	10	-	-	7	0	3	0	9	-	-	30	0.3	
		Back, Buttock	-	-	2	-	49	-	-	12	1	13	-	-	-	-	77	0.8	
	Upper Extremity	Shoulder, Upper Arm	234	8	2	-	288	18	-	15	1	10	-	1	-	-	577	6.4	19.7
		Forearm, Elbow	248	0	1	-	183	37	-	9	0	16	-	-	-	-	494	5.4	
		Wrist, Hand, Fingers	217	3	1	-	176	70	-	3	1	66	-	3	-	-	540	6.0	
		Other & Unspec.	0	-	-	-	38	9	76	11	0	23	15	1	-	-	173	1.9	
		Other & Unspec.	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Lower Extremity	Hip	45	1	0	-	-	-	-	2	0	-	-	-	-	-	48	0.5	26.7
		Upper Leg, Thigh	215	-	-	-	-	58	-	2	0	9	-	-	-	-	284	3.1	
		Knee	27	5	3	-	-	-	-	19	0	2	-	-	-	-	56	0.6	
		Lower Leg, Ankle	531	1	11	-	-	94	-	8	4	7	-	-	-	-	656	7.2	
		Foot, Toes	200	3	0	-	62	38	-	4	0	0	-	-	-	-	307	3.4	
	Other, Unspecified	Other & Unspec.	2	-	6	-	878	74	72	18	2	10	-	10	-	-	1072	11.8	1.5
		Other/Multiple	0	-	-	-	-	-	1	-	-	2	16	-	-	-	19	0.2	
		Unspec. Site	0	0	0	19	19	-	1	9	2	30	1	39	-	-	120	1.3	
	System-wide & late effects		-	-	-	-	-	-	-	-	-	-	-	-	128	-	128	1.4	100%
	Total		2738	23	52	1942	2758	398	214	207	13	387	38	164	128	11	9073		
	Percent by Nature of Injury		30.2	0.3	0.6	21.4	30.4	4.4	2.4	2.3	0.1	4.3	0.4	1.8	1.4	0.1		100%	100%

## Notes:

<sup>1</sup> Includes hospitalized traumatic battle injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).<sup>2</sup> Populated utilizing injury diagnosis codes of hospitalization cases, one traumatic injury for each case, traumatic brain injury diagnosis codes identified first.<sup>3</sup> Traumatic brain injury diagnoses are based on the Defense and Veterans Brain Injury Center traumatic brain injury ICD-9-CM codes; 'Unspecified' contains 959.01, 'System-wide & late effects' contains 907.0, and 'Postconcussion' contains 310.2.

- Table 6 is the modified Barell Matrix (described in Methods, paragraph 5e(4)) for hospitalized battle injuries. Each hospitalization (TBI case or non-TBI case) with a BI is represented only once in this matrix. For those with a TBI, only the TBI diagnosis is represented, even if there were other injuries. For hospitalizations that did not have a TBI, only the first-listed traumatic injury is represented.
- Of the 9,195 hospitalizations that were battle-related (Table 1), 98.7 percent (n=9,073) had a BI that could be categorized in this matrix. This matrix includes 2,055 battle-related TBIs (22.6 percent) and 7,018 injury non-TBI hospitalizations (77.4 percent).
- Using the CDC's TBI classification scheme, 837 of the TBIs were type 1 injuries (40.7 percent), 1,060 were type 2 (51.6 percent), and 49 were type 3 (2.4 percent). The remaining 109 TBIs (5.3 percent) could not be classified using this scheme, but were TBIs according to the DVBIC case definition.
- In regard to the nature of injury for hospitalized battle-related TBIs (n=2,055), 667 cases were categorized as a fracture (32.5 percent), 1,279 cases were internal injuries (62.2 percent), 98 cases had an unspecified injury (4.8 percent), and 11 TBI cases were classified as postconcussion syndrome (0.5 percent).
- Among the hospitalized injuries that did not have a TBI (n=7,018), 34.5 percent (n=2,423) had a lower extremity injury. These injuries accounted for 26.7 percent (2,423/9,073) of the injuries displayed in this matrix.
- There were 2,738 fractures represented in the matrix (TBI and non-TBI injuries), accounting for 30.2 percent of all injuries. Among the non-TBI hospitalizations (n=7,018), 29.5 percent (n=2,071) had a fracture. Fracture was the injury type for 667 TBIs (32.5 percent of TBIs).
- There were 1,942 internal injuries displayed in the matrix (21.4 percent of all injuries). Of these, two-thirds were TBIs (n=1,279; 65.9 percent).

Table 7. Distribution of Hospitalized Traumatic Non-Battle Injuries by Body Region and Nature of Injury, 2004–2009<sup>1-3</sup>

Body Region of Injury			Fracture	Dislocation	Sprains/ Strains	Internal	Open Wound	Amputations	Blood Vessel	Contusion/ Superficial	Crush	Burns	Nerves	Unspeci- fied	System- wide & late effects	Post- Concussion	Total	Percent	Percent by Body Region
Traumatic Brain Injury (n=849)	Head: Traumatic Brain Injury Severity Type	Type 1 TBI	86	-	-	82	-	-	-	-	-	-	0	-	-	-	168	3.1	15.5
		Type 2 TBI	36	-	-	509	-	-	-	-	-	-	-	-	-	-	545	9.9	
		Type 3 TBI	26	-	-	-	-	-	-	-	-	-	-	-	-	-	26	0.5	
		Additional DVBIC codes	-	-	-	-	-	-	-	-	-	-	-	93	2	15	110	2.0	
Non-Traumatic Brain Injury (n=4,641)	Other Head, Face, Neck	Other head	-	-	-	-	32	-	-	-	-	0	0	-	-	-	32	0.6	8.4
		Face	187	4	1	-	58	-	-	-	-	13	-	-	-	-	263	4.8	
		Eye	-	-	-	-	31	-	-	30	-	5	1	-	-	-	67	1.2	
		Neck	2	-	0	-	6	-	-	-	2	2	0	-	-	-	12	0.2	
		Head, Face, Neck Unspec.	-	-	-	-	-	-	5	28	1	42	0	13	-	-	89	1.6	
		Cervical SCI	6	-	-	5	-	-	-	-	-	-	-	-	-	-	11	0.2	
	Spinal Cord (SCI)	Thoracic/Dorsal SCI	2	-	-	1	-	-	-	-	-	-	-	-	-	-	3	0.1	0.5
		Lumbar SCI	4	-	-	1	-	-	-	-	-	-	-	-	-	-	5	0.1	
		Sacrum Coccyx SCI	0	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.0	
		Spine, Back Unspec. SCI	1	-	-	5	-	-	-	-	-	-	-	-	-	-	6	0.1	
	Vertebral Column (VCI)	Cervical VCI	20	2	53	-	-	-	-	-	-	-	-	-	-	-	75	1.4	3.4
		Thoracic/Dorsal VCI	24	0	4	-	-	-	-	-	-	-	-	-	-	-	28	0.5	
		Lumbar VCI	48	3	27	-	-	-	-	-	-	-	-	-	-	-	78	1.4	
		Sacrum Coccyx VCI	2	0	0	-	-	-	-	-	-	-	-	-	-	-	2	0.0	
	Torso	Spine, Back Unspec. VCI	3	0	-	-	-	-	-	-	-	-	-	-	-	-	3	0.1	6.4
		Chest (thorax)	32	1	2	46	8	-	2	17	16	4	0	-	-	-	128	2.3	
		Abdomen	-	-	-	64	13	-	2	12	-	3	0	-	-	-	94	1.7	
		Pelvis, Urogenital	42	1	11	2	10	-	0	3	1	0	0	-	-	-	70	1.3	
		Trunk	0	-	-	-	2	-	-	8	2	1	0	18	-	-	31	0.6	
		Back, Buttock	-	-	9	-	1	-	-	17	0	3	-	-	-	-	30	0.5	
	Upper Extremity	Shoulder, Upper Arm	71	22	13	-	14	1	-	17	2	5	-	7	-	-	152	2.8	26.5
		Forearm, Elbow	169	7	1	-	36	3	-	7	6	12	-	-	-	-	241	4.4	
		Wrist, Hand, Fingers	402	26	19	-	269	103	-	21	108	52	-	7	-	-	1007	18.3	
		Other & Unspec.	2	-	-	-	4	0	13	4	0	4	24	5	-	-	56	1.0	
	Lower Extremity	Hip	15	7	5	-	-	-	-	6	0	-	-	-	-	-	33	0.6	20.9
		Upper Leg, Thigh	44	-	-	-	-	2	-	11	5	5	-	-	-	-	67	1.2	
		Knee	18	76	16	-	-	-	-	8	1	1	-	-	-	-	120	2.2	
		Lower Leg, Ankle	416	22	55	-	-	2	-	16	7	12	-	-	-	-	530	9.7	
		Foot, Toes	109	9	2	-	16	9	-	10	25	2	-	-	-	-	182	3.3	
		Other & Unspec.	4	-	42	-	136	1	14	8	2	3	-	8	-	-	218	4.0	
	Other, Unspecified	Other/Multiple	0	-	-	-	-	-	0	-	-	-	1	1	-	-	2	0.0	1.4
		Unspec. Site	1	1	20	2	2	-	1	12	1	8	2	26	-	-	76	1.4	
System-wide & late effects			-	-	-	-	-	-	-	-	-	-	-	-	931	-	931	17.0	100%
Total			1772	181	280	718	638	121	37	235	179	178	28	177	931	15	5490		
Percent by Nature of Injury			32.3	3.3	5.1	13.1	11.6	2.2	0.7	4.3	3.3	3.2	0.5	3.2	17.0	0.3		100%	

## Notes:

<sup>1</sup> Includes hospitalized traumatic non-battle injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).<sup>2</sup> Populated utilizing injury diagnosis codes of hospitalization cases, one traumatic injury for each case, Traumatic brain injury diagnosis codes identified first.<sup>3</sup> Traumatic brain injury diagnoses are based on the Defense and Veterans Brain Injury Center traumatic brain injury ICD-9-CM codes; 'Unspecified' contains 959.01, 'System-wide & late effects' contains 907.0, and 'Postconcussion' contains 310.2.

- Table 7 is the matrix for hospitalized non-battle injuries. Each hospitalization (TBI case or non-TBI case) with an NBI is represented only once in the matrix. All non-battle-related TBIs are represented. For hospitalized injuries that did not have a TBI, only the first-listed traumatic injury is represented in the matrix.
- Of the 6,541 hospitalizations with non-battle injuries (Table 1), 83.9 percent (n=5,490) had a traumatic injury (first-listed injury) that could be categorized in this matrix (DVBIC TBI code or ICD-9-CM codes 800-995).
- Of the 5,490 NBIs in this matrix, TBIs accounted for 15.5 percent (n=849).
- Using the CDC's TBI classification scheme, 168 TBIs were classified as type 1 (19.8 percent), 545 were type 2 (64.2 percent), and 26 were type 3 (3.1 percent). The remaining TBIs (n=110; 13.0 percent) could not be classified using this scheme, but were TBIs according to the DVBIC case definition.
- The nature of injury for hospitalized non-battle-related TBIs included 148 fractures (17.4 percent), 591 internal injuries (69.6 percent), 93 unspecified injuries (11.0 percent), 2 that were system-wide or late effects of injury (0.2 percent), and 15 that were postconcussion syndrome (1.8 percent).
- Of the injuries that were not TBI (n=4,641) in the matrix, 24.8 percent were lower extremity injuries (n=1,150). These injuries accounted for 20.9 percent (1,150/5,490) of all injuries displayed in the matrix.
- There were 1,772 fractures represented in the matrix, accounting for 32.3 percent of all injuries. Among the hospitalizations that did not have a TBI, 35.0 percent (1,624/4,641) had a fracture, whereas 17.4 percent of TBIs were fractures.
- There were 718 internal injuries displayed in the matrix (13.1 percent of all injuries). Of these internal injuries, 591 (82.3 percent) were TBIs.

Table 8. Distribution of Air Evacuated Traumatic Battle Injuries by Body Region and Nature of Injury, 2004-2009<sup>1-3</sup>

Body Region of Injury			Fracture	Dislocation	Sprains/ Strains	Internal	Open Wound	Amputations	Blood Vessel	Contusion/ Superficial	Crush	Burns	Nerves	Unspeci- fied	System- wide & late effects	Post- Concussion	Total	Percent	Percent by Body Region
Traumatic Brain Injury (n=1,248)	Head: Traumatic Brain Injury Severity Type	Type 1 TBI	21	-	-	247	-	-	-	-	-	-	0	-	-	-	268	4.3	20.2
		Type 2 TBI	64	-	-	444	-	-	-	-	-	-	-	-	-	-	508	8.2	
		Type 3 TBI	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.1	
		Additional DVBIC codes	-	-	-	-	-	-	-	-	-	-	-	106	0	362	468	7.6	
Non-Traumatic Brain Injury (n=4,926)	Other Head, Face, Neck	Other head	-	-	-	-	28	-	-	-	-	1	4	-	-	-	33	0.5	10.9
		Face	164	0	0	-	88	-	-	-	-	69	-	-	-	-	321	5.2	
		Eye	-	-	-	-	85	-	-	21	-	5	2	-	-	-	113	1.8	
		Neck	2	-	0	-	86	-	-	-	1	2	1	-	-	-	92	1.5	
		Head, Face, Neck Unspec.	-	-	-	-	-	-	22	10	0	55	0	30	-	-	117	1.9	
	Spinal Cord (SCI)	Cervical SCI	4	-	-	0	-	-	-	-	-	-	-	-	-	-	4	0.1	0.5
		Thoracic/Dorsal SCI	3	-	-	1	-	-	-	-	-	-	-	-	-	-	4	0.1	
		Lumbar SCI	2	-	-	4	-	-	-	-	-	-	-	-	-	-	6	0.1	
		Sacrum Coccyx SCI	0	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.0	
		Spine, Back Unspec. SCI	1	-	-	13	-	-	-	-	-	-	-	-	-	-	14	0.2	
	Vertebral Column (VCI)	Cervical VCI	19	2	7	-	-	-	-	-	-	-	-	-	-	-	28	0.5	1.9
		Thoracic/Dorsal VCI	16	0	0	-	-	-	-	-	-	-	-	-	-	-	16	0.3	
		Lumbar VCI	42	1	1	-	-	-	-	-	-	-	-	-	-	-	44	0.7	
		Sacrum Coccyx VCI	1	0	0	-	-	-	-	-	-	-	-	-	-	-	1	0.0	
		Spine, Back Unspec. VCI	26	0	-	-	-	-	-	-	-	-	-	-	-	-	26	0.4	
	Torso	Chest (thorax)	12	0	0	62	73	-	3	6	0	0	0	-	-	-	156	2.5	8.8
		Abdomen	-	-	-	71	95	-	3	1	-	0	0	-	-	-	170	2.8	
		Pelvis, Urogenital	33	0	3	4	83	-	3	0	0	0	0	-	-	-	126	2.0	
		Trunk	1	-	-	-	14	-	-	1	0	3	0	23	-	-	42	0.7	
		Back, Buttock	-	-	2	-	39	-	-	1	0	5	-	-	-	-	47	0.8	
	Upper Extremity	Shoulder, Upper Arm	144	20	16	-	135	15	-	5	0	3	-	20	-	-	358	5.8	20.1
		Forearm, Elbow	204	4	2	-	80	19	-	1	0	2	-	-	-	-	312	5.1	
		Wrist, Hand, Fingers	143	5	4	-	94	46	-	5	3	45	-	24	-	-	369	6.0	
		Other & Unspec.	11	-	-	-	82	17	22	2	0	10	54	7	-	-	205	3.3	
	Lower Extremity	Hip	55	4	1	-	-	-	-	1	0	-	-	-	-	-	61	1.0	29.7
		Upper Leg, Thigh	124	-	-	-	-	37	-	1	0	2	-	-	-	-	164	2.7	
		Knee	23	48	7	-	-	-	-	2	0	0	-	-	-	-	80	1.3	
		Lower Leg, Ankle	474	5	13	-	-	68	-	2	2	3	-	-	-	-	567	9.2	
		Foot, Toes	155	1	1	-	44	44	-	2	2	2	-	-	-	-	251	4.1	
	Other, Unspecified	Other & Unspec.	11	-	11	-	486	85	29	8	0	3	-	81	-	-	714	11.6	7.0
		Unspec. Site	6	-	-	-	-	-	0	-	-	6	15	-	-	-	27	0.4	
	System-wide & late effects		-	-	-	-	-	-	-	-	-	-	-	-	56	-	56	0.9	
	Total		1878	93	70	864	1606	331	88	75	8	342	84	319	56	362	6176		
	Percent by Nature of Injury		30.4	1.5	1.1	14.0	26.0	5.4	1.4	1.2	0.1	5.5	1.4	5.2	0.9	5.9		100%	100%

## Notes:

<sup>1</sup> Includes air evacuated traumatic battle injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).<sup>2</sup> Populated utilizing injury diagnosis codes from air evacuation records, one traumatic injury for each case, Traumatic brain injury diagnosis codes identified first.<sup>3</sup> Traumatic brain injury diagnoses are based on the Defense and Veterans Brain Injury Center traumatic brain injury ICD-9-CM codes; 'Unspecified' contains 959.01, 'System-wide & late effects' contains 907.0, and 'Postconcussion' contains 310.2.

- Table 8 is the matrix for air evacuated battle injuries. Each air evacuation (TBI case or non-TBI case) with a BI is represented only once in the matrix. All of the battle-related TBIs are represented. For air evacuations that did not have a TBI, only the first-listed traumatic injury is represented in the matrix.
- Of the 7,778 air evacuated battle-related injuries (Table 1), 79.4 percent (n=6,176) had a traumatic injury (first-listed injury) that could be categorized in this matrix (DVBIC TBI code or ICD-9-CM codes 800-995).
- TBIs accounted for 20.2 percent (n=1,248) of the injuries in this matrix.
- Using the CDC's TBI classification scheme, there were 268 type 1 injuries (21.5 percent), 508 type 2 injuries (40.7 percent), 4 type 3 injuries (0.3 percent), and 468 injuries (37.5 percent) that could not be classified using this scheme, but were TBIs based on the DVBIC case definition.
- Concerning the nature of injury for these battle-related TBIs, 89 cases were fracture (7.1 percent), 691 cases were internal injury (55.4 percent), 106 cases were unspecified injury (8.5 percent), and 362 TBI cases were postconcussion syndrome (29.0 percent).
- Of the injuries that were not TBI (n=4,928) in the matrix, 37.3 percent (n=1,837) were lower extremity injuries. These injuries accounted for 29.7 percent of all injuries in the matrix.
- There were 1,878 fractures represented in the matrix, accounting for 30.4 percent of all injuries. Among the air evacuations that did not have a TBI, 36.3 percent (1,789/4,928) had a fracture, whereas only 7.1 percent of TBIs were fractures.
- There were 864 internal injuries displayed in the matrix (14.0 percent of all injuries). Of these internal injuries, 691 (80.0 percent) were TBIs.

Table 9. Distribution of Air Evacuated Traumatic Non-Battle Injuries by Body Region and Nature of Injury, 2004-2009<sup>1-3</sup>

Body Region of Injury			Fracture	Dislocation	Sprains/ Strains	Internal	Open Wound	Amputations	Blood Vessel	Contusion/ Superficial	Crush	Burns	Nerves	Unspeci- fied	System- wide & late effects	Post- Concussion	Total	Percent	Percent by Body Region
Traumatic Brain Injury (n=426)	Head: Traumatic Brain Injury Severity Type	Type 1 TBI	3	-	-	71	-	-	-	-	-	-	0	-	-	-	74	1.0	5.8
		Type 2 TBI	17	-	-	119	-	-	-	-	-	-	-	-	-	-	136	1.9	
		Type 3 TBI	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.0	
		Additional DVBIC codes	-	-	-	-	-	-	-	-	-	-	-	65	1	143	209	2.9	
Non-Traumatic Brain Injury (n=6,364)	Other Head, Face, Neck	Other head	-	-	-	-	7	-	-	-	-	0	1	-	-	-	8	0.1	3.3
		Face	117	0	0	-	16	-	-	-	-	13	-	-	-	-	146	2.0	
		Eye	-	-	-	-	18	-	-	18	-	3	1	-	-	-	40	0.5	
		Neck	1	-	0	-	1	-	-	-	1	0	12	-	-	-	15	0.2	
		Head, Face, Neck Unspec.	-	-	-	-	-	-	5	1	0	12	0	13	-	-	31	0.4	
		Cervical SCI	7	-	-	11	-	-	-	-	-	-	-	-	-	-	-	18	
	Thoracic/Dorsal SCI	4	-	-	1	-	-	-	-	-	-	-	-	-	-	-	5	0.1	
	Lumbar SCI	3	-	-	18	-	-	-	-	-	-	-	-	-	-	-	21	0.3	
	Sacrum Coccyx SCI	1	-	-	5	-	-	-	-	-	-	-	-	-	-	-	6	0.1	
	Spine, Back Unspec. SCI	4	-	-	16	-	-	-	-	-	-	-	-	-	-	-	20	0.3	2.5
	Cervical VCI	29	5	32	-	-	-	-	-	-	-	-	-	-	-	-	66	0.9	
	Thoracic/Dorsal VCI	13	0	4	-	-	-	-	-	-	-	-	-	-	-	-	17	0.2	
	Lumbar VCI	39	3	33	-	-	-	-	-	-	-	-	-	-	-	-	75	1.0	
	Sacrum Coccyx VCI	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	6	0.1	
	Spine, Back Unspec. VCI	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	20	0.3	
	Chest (thorax)	20	1	5	21	6	-	1	3	1	2	0	-	-	-	-	60	0.8	
	Abdomen	-	-	-	22	9	-	2	0	-	0	10	-	-	-	-	43	0.6	
	Pelvis, Urogenital	65	2	8	1	7	-	0	0	0	2	2	-	-	-	-	87	1.2	36.7
	Trunk	1	-	-	-	0	-	-	1	1	1	0	10	-	-	-	14	0.2	
	Back, Buttock	-	-	31	-	1	-	-	3	3	1	-	-	-	-	-	39	0.5	
	Shoulder, Upper Arm	136	306	436	-	15	2	-	15	2	1	-	44	-	-	-	957	13.1	
	Forearm, Elbow	286	37	25	-	11	2	-	1	5	5	-	-	-	-	-	372	5.1	
	Wrist, Hand, Fingers	548	68	80	-	159	84	-	15	46	31	-	112	-	-	-	1143	15.7	
	Other & Unspec.	7	-	-	-	5	1	5	2	2	10	159	10	-	-	-	201	2.8	
	Hip	31	18	24	-	-	-	-	3	0	-	-	-	-	-	-	76	1.0	
	Upper Leg, Thigh	53	-	-	-	-	0	-	2	0	3	-	-	-	-	-	58	0.8	5.8
	Knee	41	946	155	-	-	-	-	11	2	0	-	-	-	-	-	1155	15.9	
	Lower Leg, Ankle	649	31	141	-	-	2	-	7	5	5	-	-	-	-	-	840	11.5	
	Foot, Toes	240	22	25	-	31	4	-	16	16	1	-	-	-	-	-	355	4.9	
	Other & Unspec.	14	-	159	-	57	0	8	5	1	5	-	114	-	-	-	363	5.0	
	Other/Multiple	2	-	-	-	-	-	1	-	-	0	24	-	-	-	-	27	0.4	
	Unspec. Site	228	31	53	0	14	-	1	6	4	35	12	11	-	-	-	395	5.4	100%
	System-wide & late effects			-	-	-	-	-	-	-	-	-	-	-	185	-	185	2.5	
	Total			2583	1472	1212	285	357	95	23	109	89	130	221	379	185	143	7284	
Percent by Nature of Injury			35.5	20.2	16.6	3.9	4.9	1.3	0.3	1.5	1.2	1.8	3.0	5.2	2.5	2.0		100%	

## Notes:

<sup>1</sup> Includes traumatic air evacuated traumatic non-battle injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).<sup>2</sup> Populated utilizing injury diagnosis codes of air evacuation records, one traumatic injury for each case, Traumatic brain injury diagnosis codes identified first.<sup>3</sup> Traumatic brain injury diagnoses are based on the Defense and Veterans Brain injury Center traumatic brain injury ICD-9-CM codes; 'Unspecified' contains 959.01, 'System-wide & late effects' contains 907.0, and 'Postconcussion' contains 310.2.

- Table 9 is the matrix for air evacuated non-battle injuries. Each air evacuation (TBI case or non-TBI case) with an NBI is represented only once in the matrix. All of the non-battle-related TBIs are represented, even if these cases had other injuries. For air evacuations that did not have a TBI, only the first-listed traumatic injury is represented in the matrix.
- Of the 14,196 non-battle injuries that were air evacuated during this period (Table 1), 51.3 percent (n=7,284) had a traumatic injury (first-listed injury) that could be categorized in this matrix (DVBIC TBI code or ICD-9-CM codes 800-995).
- TBIs accounted for 5.8 percent (n=420) of the injuries in this matrix.
- Using the CDC's TBI classification scheme, there were 74 type 1 injuries (17.6 percent), 136 type 2 injuries (32.4 percent), 1 type 3 injury (0.2 percent), and 209 cases (49.8 percent) that could not be classified using this scheme, but were TBIs based on the DVBIC case definition.
- In regard to the nature of injury for these non-battle-related TBIs, 21 TBIs were fracture (5.0 percent), 190 TBIs were internal injury (45.2 percent), 65 TBIs were unspecified injuries (15.5 percent), 1 TBI was system-wide or late effects of injury (0.2 percent), and 143 TBIs were classified as postconcussion syndrome (34.0 percent).
- Of the injuries that were not TBI (n=6,864) in the matrix, 41.5 percent (n=2,847) were lower extremity injuries. These injuries accounted for 39.1 percent of all injuries in the matrix.
- There were 2,583 fractures represented in the matrix, accounting for 35.5 percent of all injuries. Only 21 of these fractures (0.8 percent) were TBIs.
- There were 285 internal injuries displayed in the matrix (3.9 percent of all injuries). Of these internal injuries, 190 (66.7 percent) were TBIs.

Table 10. Comparison by Casualty Type of the Injury Classifications and Natures of Injury from the Modified Barell Matrices for Hospitalized and Air Evacuated Traumatic Brain Injuries, 2004-2009<sup>1,2</sup>

	Hospitalized TBI Casualty Type						Air Evacuated TBI Casualty Type					
	BI		NBI		Unknown		BI		NBI		Unknown	
<b>TBI Classification</b>	<b>n</b>	<b>%</b>	<b>n</b>	<b>%</b>	<b>n</b>	<b>%</b>	<b>n</b>	<b>%</b>	<b>n</b>	<b>%</b>	<b>n</b>	<b>%</b>
Type 1	837	40.7	168	19.8	0	0.0	268	21.5	74	17.6	41	16.5
Type 2	1,060	51.6	545	64.2	1	1.8	508	40.7	136	32.4	71	28.5
Type 3	49	2.4	26	3.1	0	0.0	4	0.3	1	0.2	0	0.0
Additional DVBIC codes	109	5.3	110	13.0	54	98.2	468	37.5	209	49.8	137	55.0
<b>Total</b>	<b>2,055</b>	<b>100.0</b>	<b>849</b>	<b>100.0</b>	<b>55</b>	<b>100.0</b>	<b>1248</b>	<b>100.0</b>	<b>420</b>	<b>100.0</b>	<b>249</b>	<b>100.0</b>
<b>Nature of Injury<sup>3</sup></b>												
Internal	1,279	62.2	591	69.6	1	1.8	691	55.4	190	45.2	111	44.6
Fracture	667	32.5	148	17.4	0	0.0	89	7.1	21	5.0	0	0.0
Unspecified injury	98	4.8	93	11.0	0	0.0	106	8.5	65	15.5	2	0.8
Postconcussion	11	0.5	15	1.8	54	98.2	362	29.0	143	34.0	135	54.2
Nerves	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
System wide & late effects	0	0.0	2	0.2	0	0.0	0	0.0	1	0.2	0	0.0
<b>Total</b>	<b>2,055</b>	<b>100.0</b>	<b>849</b>	<b>100.0</b>	<b>55</b>	<b>100.0</b>	<b>1248</b>	<b>100.0</b>	<b>420</b>	<b>100.0</b>	<b>249</b>	<b>100.0</b>

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (OIF and OEF).

<sup>2</sup> Traumatic brain injury was identified from any-listed injury diagnosis in the hospitalization or air evacuation record.

<sup>3</sup> Nature of injury categories are listed in order from highest to lowest based on hospitalized battle-related traumatic brain injuries.

- Combining data from the modified Barell matrices in Tables 6 through 9, Table 10 allows comparison by casualty type of the hospitalized and air evacuated TBIs, using the CDC's classifications for injury type and nature of injury (see paragraph, 5c(1)(d)).

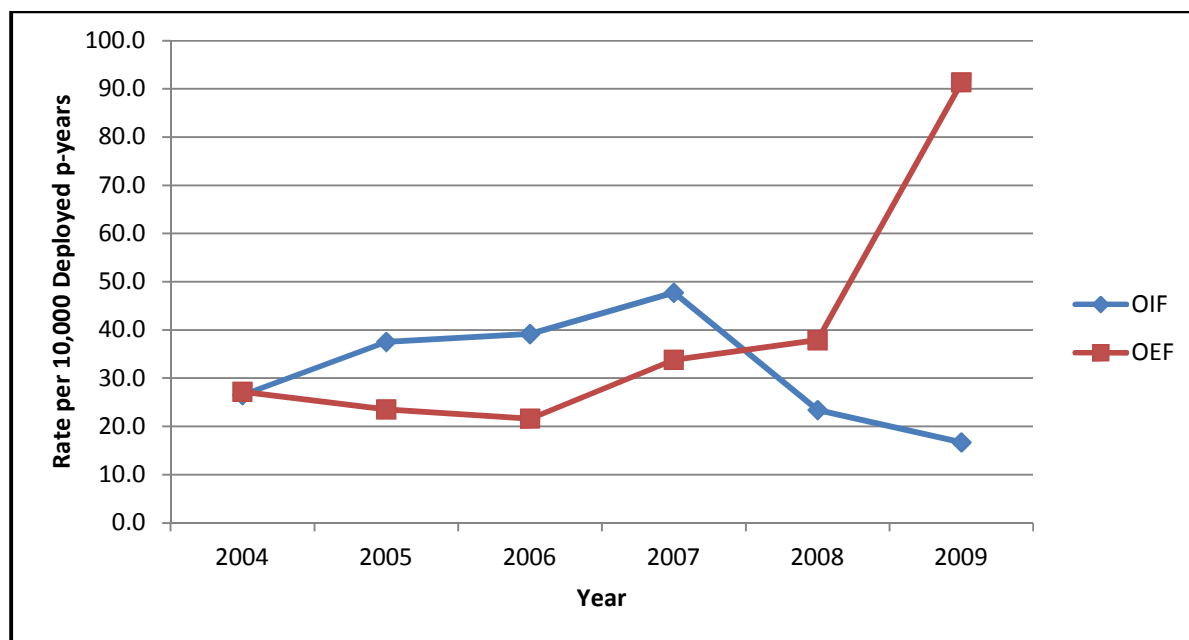
#### CDC's TBI Classification:

- Based on the proportions of battle-related TBIs that were type 1 or type 2 injuries, the hospitalized TBIs tended to be more serious than the air evacuated battle-related TBIs (that, is higher proportions of hospitalized TBIs were types 1 or 2).
- Similarly, based on the proportions of non-battle-related TBIs that were type 1 or type 2 injuries, the hospitalized TBIs tended to be more serious than the air evacuated non-battle-related TBIs (that, is higher proportions of hospitalized TBIs were types 1 or 2).
- More, and higher proportions, of the air evacuated TBIs of each casualty type were not classifiable into types 1, 2, or 3 compared to the hospitalized TBIs. These TBIs were identified using the DVBIC TBI case definition and included the unspecified TBIs, system-wide and late effect TBIs, and the postconcussion syndrome cases.

#### Nature of Injury:

- In regard to the nature of injury for TBIs, internal injury was the leading category for hospitalized TBIs (62.2 percent), hospitalized TBIs (69.6 percent), air evacuated TBIs (55.4 percent), and air evacuated TBIs (45.5 percent).
- Fractures was the second leading category for hospitalized battle- and non-battle-related TBIs (32.5 percent and 17.4 percent, respectively). But fractures accounted for much smaller proportions of the air evacuated battle- and non-battle-related TBIs.
- Postconcussion syndrome was the leading nature of injury for hospitalized and air evacuated TBIs that were "unknown injury" casualty type (hospitalized: 98.2 percent; air evacuated: 54.2 percent), and the second leading nature of injury for air evacuated battle- and non-battle-related TBIs (29.0 percent and 34.0 percent respectively).

b. Annual Rates for Traumatic Brain Injury.



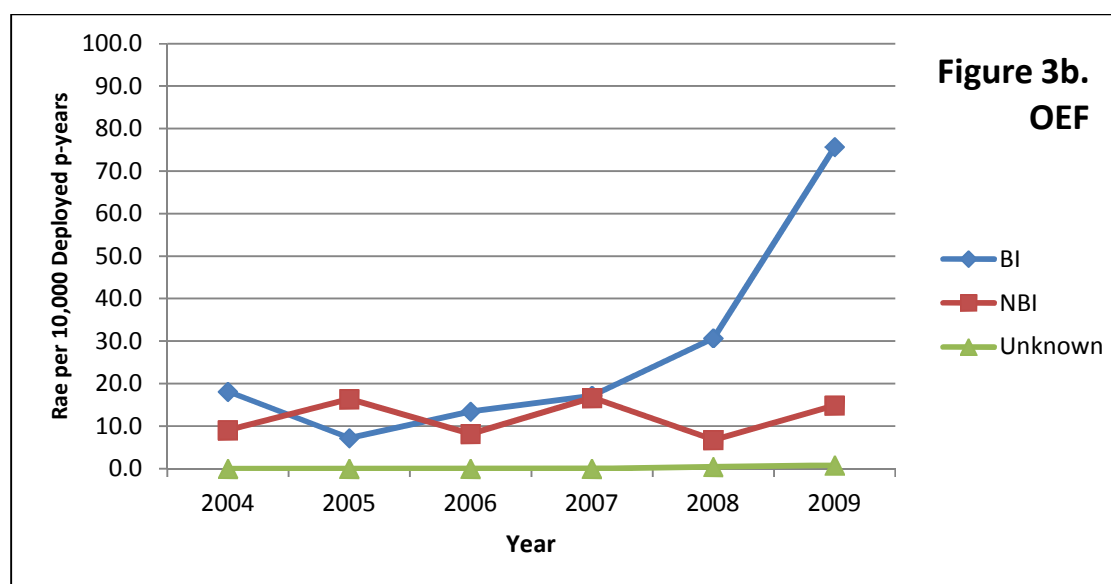
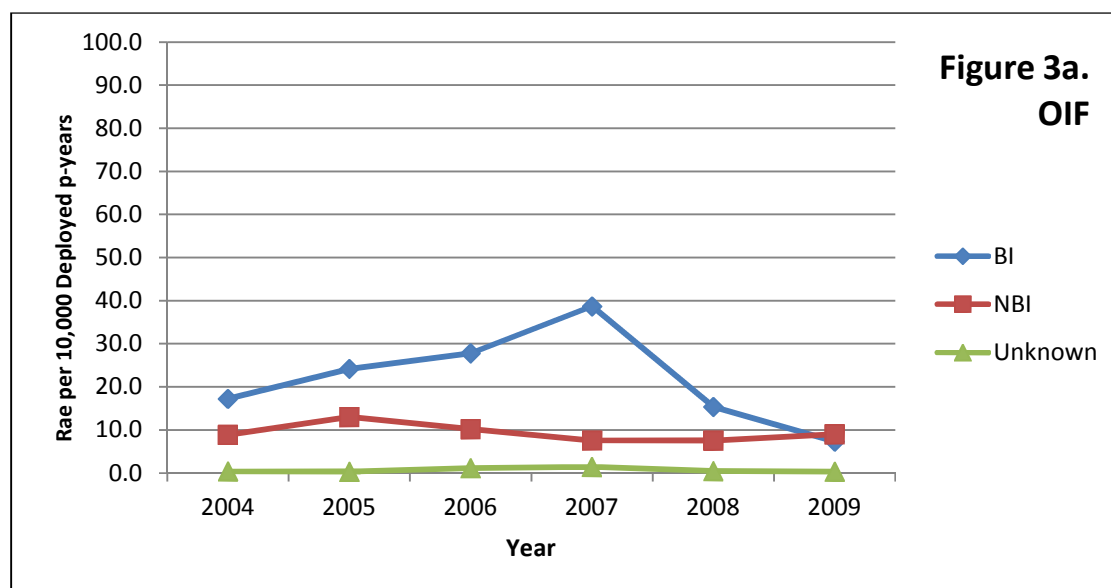
Notes:

<sup>1</sup> Rates: traumatic brain injuries per 10,000 deployed p-years

<sup>2</sup> Hospitalized traumatic brain injuries include all casualty types (that is, battle injury, non-battle injury, and unknown); Operation Iraqi Freedom: n=2,355; Operation Enduring Freedom: n=604

Figure 2. Annual Rates<sup>1</sup> for Hospitalized Traumatic Brain Injury for Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF), 2004–2009<sup>2</sup>

- Figure 2 presents the annual rates for hospitalized TBIs for OIF and OEF.
- The overall rate of hospitalized TBIs for OIF was 31.8 per 10,000 deployed p-years compared to 48.2 per 10,000 deployed p-years for OEF ( $p < .01$ ).
- From 2004 to 2007, annual hospitalized TBI rates in OIF increased each year but then dropped in 2008 and again 2009.
- The annual rate for OEF decreased in 2005 and 2006, but then increased in 2007, 2008, and 2009.



Notes:

<sup>1</sup> Rates: traumatic brain injuries per 10,000 deployed p-years

<sup>2</sup> Operation Iraqi Freedom TBIs include battle injury (n=1,610), non-battle injury (n=694) and unknown (n=51) casualty types.

<sup>3</sup> Operation Enduring Freedom TBIs include battle injury (n=445), non-battle injury (n=155), unknown (n=4) casualty types.

Figures 3a (OIF) and 3b (OEF). Annual Rates<sup>1</sup> for Hospitalized Traumatic Brain Injury by Casualty Type (Battle Injury [BI]; Non-Battle Injury [NBI]; Unknown) for Operations Iraqi Freedom (OIF)<sup>2</sup> and Enduring Freedom (OEF)<sup>3</sup>, 2004-2009

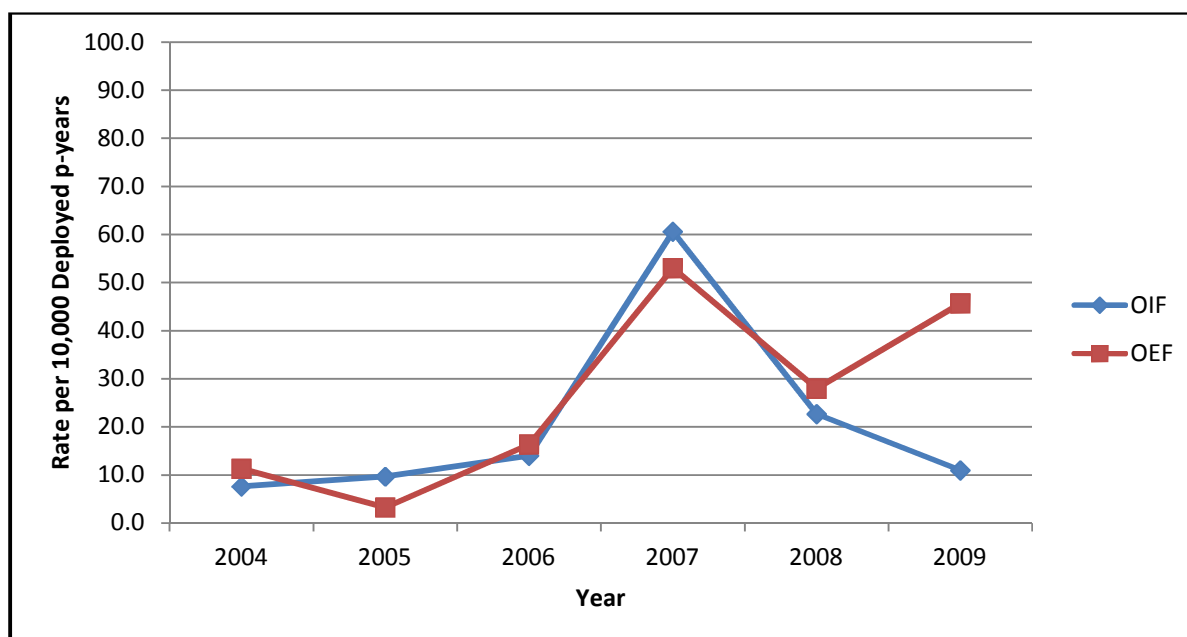
- Figures 3a and 3b present the annual rates for hospitalized TBIs by casualty type for OIF and OEF, respectively.

OIF (Figure 3a):

- OIF TBI rates for the hospitalized battle injuries increased from 2004-2007 peaking in 2007 (38.7 hospitalized TBIs per 10,000 deployed p-years) before falling rather suddenly in 2008 (15.4 per 10,000 deployed p-years), then falling again in 2009 to 7.3 per 10,000 deployed p-years. This trend in TBI BI rates for 2007, 2008, and 2009 coincides with the trend shown in Figure 2 for the overall OIF TBI rates.
- The overall rate for TBIs that were from non-battle injuries was 9.4 per 10,000 deployed p-years and the rate for the unknown casualty type TBIs was 0.7 per 10,000 deployed p-years. The rate for TBIs that were from non-battle injuries peaked in 2005 (13.0 per 10,000 deployed p-years).

OEF (Figure 3b):

- The OEF TBI rate for the hospitalized battle injuries was 18.1 per 10,000 deployed p-years in 2004, but decreased in 2005 (7.2 per 10,000 deployed p-years). But the annual TBI rates for battle injuries then increased each year thereafter, reaching 75.7 hospitalized TBIs per 10,000 deployed p-years in 2009. This trend in the BI TBI rate coincides with the overall OEF trend shown in Figure 2.
- The OEF TBI rate for hospitalized non-battle injuries fluctuated from 2004 through 2009, ranging from 6.8 per 10,000 deployed p-years in 2008 to 16.7 per 10,000 deployed p-years in 2007 with an overall rate of 12.4 per 10,000 deployed p-years.
- The overall trend in OIF and OEF BI rates for hospitalized TBIs follow the trend for the number of Soldiers assigned to each of these operations (see Appendix E). For OIF, there was a surge in the number of Soldiers assigned in 2007. For OEF, the number of Soldiers assigned has trended higher in 2008 and 2009.



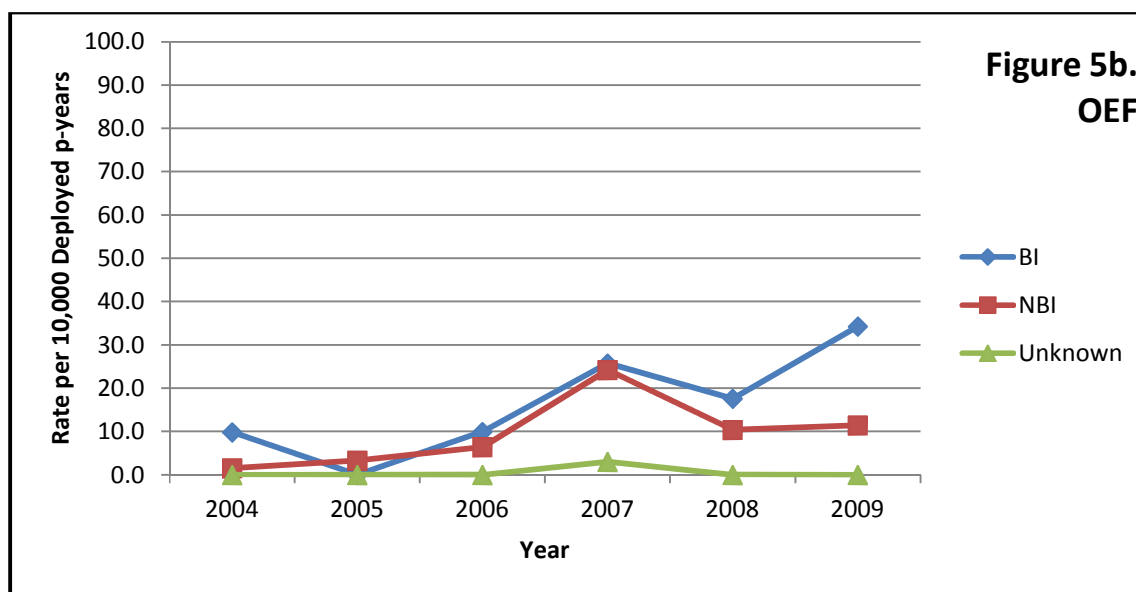
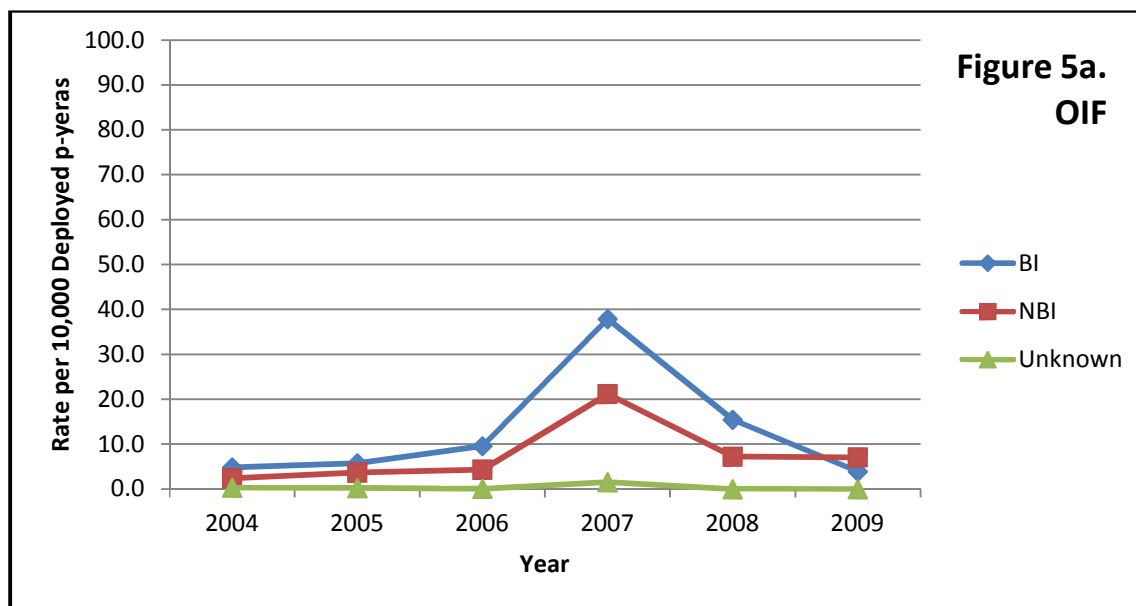
Notes:

<sup>1</sup> Rates: traumatic brain injuries per 10,000 deployed p-years

<sup>2</sup> Air evacuated traumatic brain injuries include all casualty types (that is, battle injury, non-battle injury, and unknown); Operation Iraqi Freedom: n=1,530; Operation Enduring Freedom: n=387.

Figure 4. Annual Rates<sup>1</sup> for Air Evacuated Traumatic Brain Injury for Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF)<sup>2</sup>, 2004–2009

- Figure 4 presents the annual rates for air evacuated TBIs for OIF and OEF.
- The overall air evacuated TBI rate for OEF was higher (30.9 per 10,000 deployed p-years;  $p < .01$ ) than the rate for OIF (20.7 per 10,000 deployed p-years). This overall difference was due primarily to the large increase in the OEF rate in 2009 while the OIF rate decreased.
- The annual air evacuated TBI rate was highest for both OIF and OEF in calendar year 2007. In 2007, the air evacuation TBI rate was 60.6 per 10,000 deployed p-years for OIF and 53.0 per 10,000 deployed p-years for OEF. In 2009, the air evacuated TBI rates diverge for OIF (11.0 per 10,000 deployed p-years) and OEF (45.7 per 10,000 deployed p-years).
- The overall rates for OIF and OEF hospitalized TBIs (Figure 2) are higher than the rates for OIF and OEF air evacuated TBIs (Figure 4).



Notes:

<sup>1</sup> Rates: traumatic brain injuries per 10,000 deployed p-years.

<sup>2</sup> Operation Iraqi Freedom TBIs include battle injury (n=945), non-battle injury (n=557) and unknown (n=28) casualty types.

<sup>3</sup> Operation Enduring Freedom TBIs include battle injury (n=249), non-battle injury (n=132), unknown (n=6) casualty types.

Figures 5a. & 5b. Annual Rates<sup>1</sup> for Air Evacuated Traumatic Brain Injuries By Casualty Type (Battle Injury [BI]; Non-Battle Injury [NBI]; Unknown) for Operations Iraqi Freedom (OIF)<sup>2</sup> and Enduring Freedom (OEF)<sup>3</sup>, 2004-2009

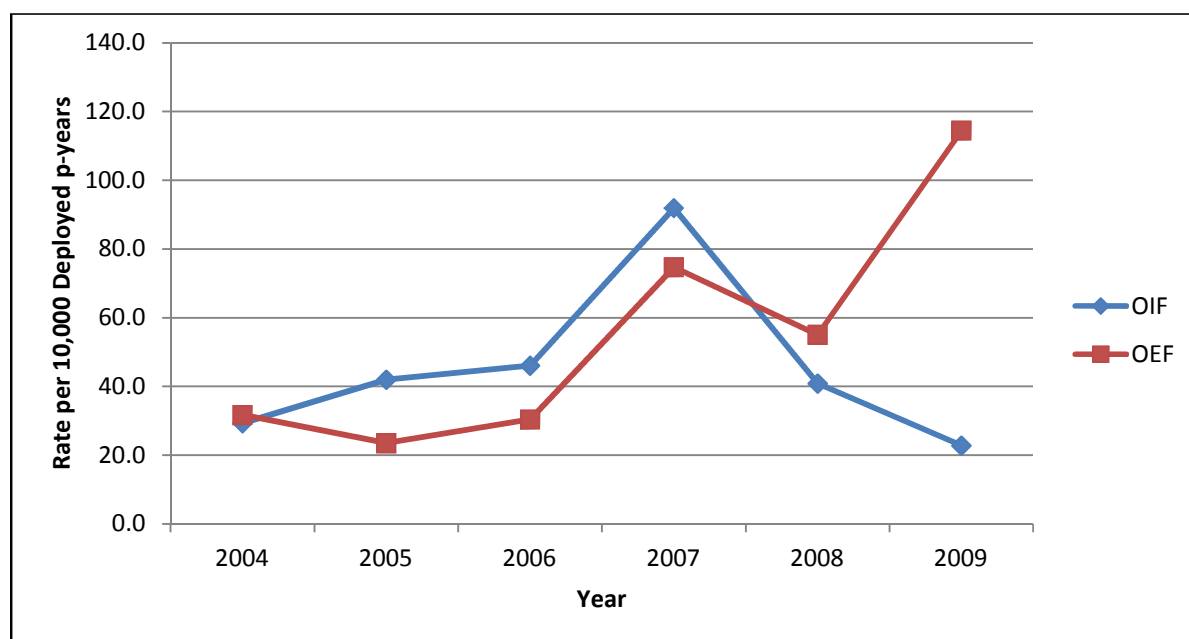
- Figures 5a and 5b present the annual rates for air evacuated TBIs by casualty type for OIF and OEF, respectively.

OIF (Figure 5a):

- The overall OIF air evacuated TBI rate was 12.8 per 10,000 deployed p-years for BI, 7.5 per 10,000 deployed p-years for NBI, and 0.4 per 10,000 deployed p-years for unknown TBI casualty type.
- The OIF rates for air evacuated TBIs depict a similar trend for BI and NBI. For OIF, both rates peaked in 2007. The BI rate in 2007 was 37.9 per 10,000 deployed p-years; the NBI rate in 2007 was 21.2 per 10,000 deployed p-years.

OEF (Figure 5b):

- The overall OEF air evacuated TBI rate was 19.9 per 10,000 deployed p-years for BI, 10.5 per 10,000 deployed p-years for NBI, and 0.5 per 10,000 deployed p-years for unknown TBI casualty type.
- The rates of air evacuated TBIs for OEF tended to increase for BIs and NBIs from 2004 to 2007. The 2009 rate for BI TBI was 34.3 per 10,000 deployed p-years.



Notes:

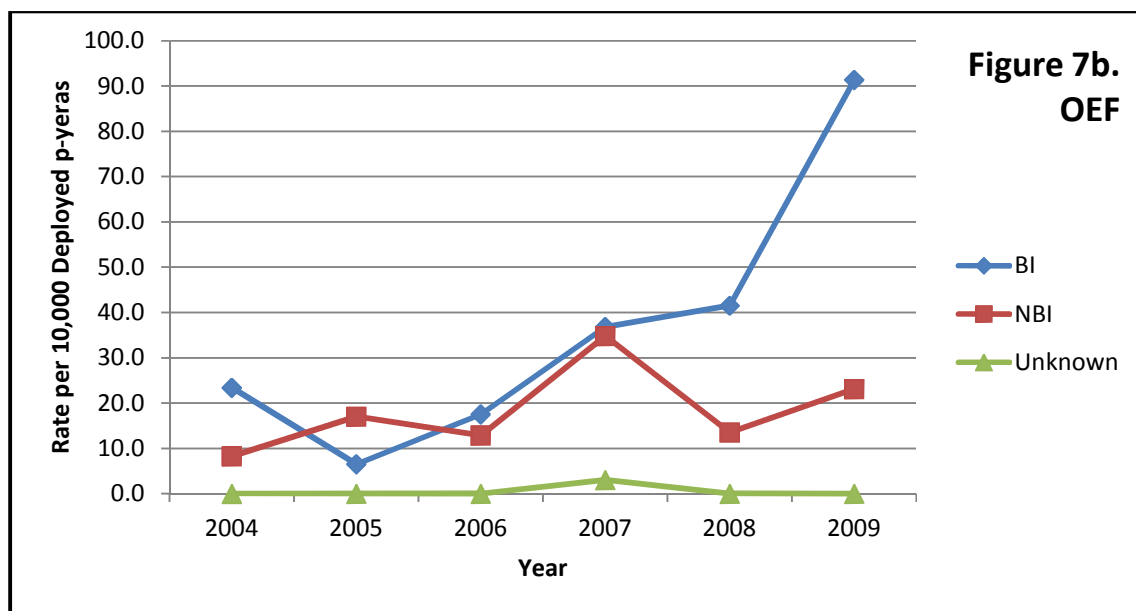
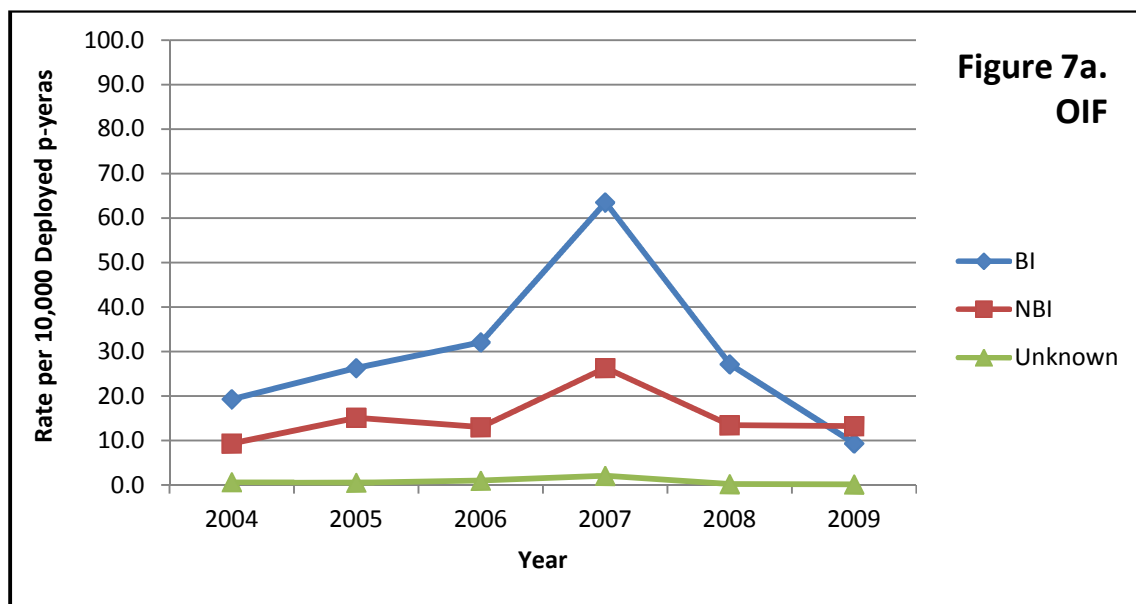
<sup>1</sup> Rates: traumatic brain injuries per 10,000 deployed p-years

<sup>2</sup> Traumatic brain injuries include all casualty types (that is, battle injury, non-battle injury, and unknown); Operation Iraqi Freedom: n=3,351; Operation Enduring Freedom; n=831.

Figure 6. Annual Rates<sup>1</sup> for Incident Traumatic Brain Injury Cases<sup>2</sup> for Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF), 2004-2009

- Figure 6 presents the annual TBI rates for OIF and OEF based on the total number of incident TBI cases that were identified from the hospitalization and air evacuation records. These rates are inclusive of all identified TBIs and are, therefore, higher for both operations than those presented in the previous figures for hospitalized (Figures 2, 3a, and 3b) and air evacuated (Figures 4, 5a, and 5b). (Note: The y-axis scale on this figure is larger than the scale used on Figures 2–5b and 6a-6b.)
- The overall rate of TBIs for OIF was 45.3 per 10,000 deployed p-years compared to 66.4 per 10,000 deployed p-years for OEF ( $p<.01$ ).
- From 2004 to 2007, annual TBI rates for OIF increased each year. The OIF rate for 2007 was 91.9 per 10,000 deployed p-years, but it then decreased for 2008 and 2009 (rate for 2009: 22.8 per 10,000 deployed p-years).

- The annual rate for OEF began to increase sharply in 2007 (74.7 per 10,000 deployed p-years) and again in 2009 (114.5 per 10,000 deployed p-years).



Notes:

<sup>1</sup> Rates: traumatic brain injuries per 10,000 deployed p-years

<sup>2</sup> Operation Iraqi Freedom TBIs include battle injury (n=2,184), non-battle injury (n=1,108) and unknown (n=59) casualty types.

<sup>3</sup> Operation Enduring Freedom TBIs include battle injury (n=580), non-battle injury (n=245), and unknown (n=6) casualty types.

Figures 7a (OIF) & 7b (OEF). Annual Rates<sup>1</sup> for Incident Traumatic Brain Injury Cases by Casualty Type (Battle Injury [BI]; Non-Battle Injury [NBI]; Unknown) for Operations Iraqi Freedom (OIF)<sup>2</sup> and Enduring Freedom (OEF)<sup>3</sup>, 2004-2009

- Figures 7a and 7b presents the incident TBI rates by casualty type for OIF and OEF based on the total number of incident TBI cases that were identified from the hospitalization and air evacuation records. These rates are inclusive of all identified TBIs and are, therefore, higher for both operations than those presented in the previous figures for hospitalized (Figures 2, 3a, and 3b) and air evacuated (Figures 4, 5a, and 5b).

OIF (Figure 7a):

- The overall OIF TBI rate was 29.5 per 10,000 deployed p-years for BI, 15.0 per 10,000 deployed p-years for NBI, and 0.8 per 10,000 deployed p-years for unknown TBI casualty type.
- The OIF rates of TBI depict a similar trend for BI and NBI, both rates peaking in 2007 and then decreasing in 2008 and 2009. In 2007, the BI rate was 63.5 per 10,000 deployed p-years and the NBI rate was 26.3 per 10,000 deployed p-years.

OEF (Figure 7b):

- The overall OEF TBI rate was 46.3 per 10,000 deployed p-years for BI, 19.6 per 10,000 deployed p-years for NBI, and 0.5 per 10,000 deployed p-years for unknown TBI casualty type.
- The overall BI rate for OEF was much higher than the BI rates for OIF due primarily to the much higher OEF rates in 2008 and 2009.
- The NBI rate for OEF tended to increase from 2004 to 2007 and then decreased in 2008. The OEF BI rate decreased in 2005, but then increased each year thereafter. In 2009 the BI rates was 91.4 TBI cases per 10,000 deployed p-years.

c. Causes of Hospitalized and Air Evacuated Traumatic Brain Injuries.

Table 11. Distribution of Battle-Related Causes of Hospitalized and Air Evacuated Traumatic Brain Injury, 2004-2009<sup>1</sup>

Battle-Related Causes of Injury <sup>2</sup>	Hospitalized		Air Evacuated	
	n	%	n	%
Shrapnel/Shell fragment	1,214	59.1	3	0.2
Other conventional weapon	361	17.6	11	0.9
Bullets	220	10.7	61	4.9
Mortar	79	3.8	46	3.7
Rocket	77	3.7	15	1.2
IED/Mine/Bomb	42	2.0	991	79.4
Grenade	41	2.0	88	7.1
Own Instrument of War	4	0.2	3	0.2
Aircraft Crash	1	0.0	1	0.1
Falls/Near-falls	1	0.0	6	0.5
Crushing/Bumping/Piercing	0	0.0	5	0.4
Fire	0	0.0	1	0.1
Explosion	0	0.0	3	0.2
Other <sup>3,4</sup>	14	0.7	11	9
Missing	1	0.0	3	0.2
<b>Total</b>	<b>2,055</b>	<b>100.0</b>	<b>1,248</b>	<b>100.0</b>

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).

<sup>2</sup> Battle-related causes of injury are listed in rank order based on hospitalized traumatic brain injuries.

<sup>3</sup> Other category for hospitalized includes 13 hostile motor vehicle crashes and 1 drowning.

<sup>4</sup> Other category for air evacuated includes hostile motor vehicle crashes (n=7), late complications (n=1), poison (n=1), excessive heat (n=1), and fighting (n=1).

- Table 11 presents the distribution of the battle-related causes of hospitalized and air evacuated TBI. The causes of injury are listed in rank order based on the hospitalized TBIs.
- The leading cause of hospitalized TBIs for battle injury was shrapnel or shell fragments, accounting for 59.1 percent of battle-related causes. Other conventional weapon and bullets represented 17.6 percent and 10.7 percent of the hospitalized BI TBIs, respectively.
- The leading cause of air evacuated battle-related TBIs was IEDs, mines, and bombs (79.4 percent). Other leading causes of air evacuated TBIs were grenades (7.1 percent), bullets (4.9 percent), and mortars (3.7 percent).

Table 12. Distribution of Non-Battle-Related Causes of Hospitalized and Air Evacuated Traumatic Brain Injury, 2004-2009<sup>1</sup>

Non-Battle Causes of Injury <sup>2</sup>	Hospitalized		Air Evacuated	
	n	%	n	%
Motor Vehicle Crashes	355	41.8	122	29.5
Falls	172	20.3	68	16.2
Sports/PT	59	6.9	35	7.9
Blunt Trauma	46	5.4	72	17.1
Air Transport Mishaps	35	4.1	16	3.8
Own Weapon (Non-wartime)	19	2.2	11	2.4
Fighting	15	1.8	8	1.7
Machinery and Tools	10	1.2	7	1.7
Unspecified	7	0.8	48	12.1
Own Instruments of War	2	0.2	1	0.2
Other <sup>3,4</sup>	129	15.2	32	7.4
<b>Total</b>	<b>849</b>	<b>100.0</b>	<b>420</b>	<b>100.0</b>

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).

<sup>2</sup> Non-battle causes of injury are listed in rank order based on hospitalized traumatic brain injuries.

<sup>3</sup> Other category for hospitalizations includes other specified causes (n=108), enemy instruments of war (n=6), late effects of injury (n=3), cutting/piercing (n=3), environmental factors (n=3), toxic substances (n=2), heat/fire/corrosives (n=3), and boarding and alighting (n=1).

<sup>4</sup> Other category for air evacuations includes non-battle injuries caused by late effects of injury (n=6), lifting, pushing, pulling (n=6), boarding and alighting (n=5), environmental factors (n=4), toxic substances (n=4), shoes/clothing (n=3), heat/fire/corrosives (n=2), medical complications (n=1), and cutting/piercing (n=1).

- Table 12 presents the distribution of the non-battle-related causes of hospitalized and air evacuated TBI. The causes of injury are listed in rank order based on the hospitalized TBIs.
- Non-battle injuries accounted for 28.6 percent of the hospitalized TBIs (n=849). The three leading non-battle causes of hospitalized TBIs included:
  - Motor vehicle crashes accounted for 41.8 percent of non-battle TBI hospitalizations.
  - Falls accounted for 20.3 percent of non-battle TBI hospitalizations.
  - Sports/PT accounted for 6.9 percent of non-battle TBI hospitalizations.

- Non-battle injuries accounted for 21.9 percent of the air evacuated TBIs (n=420). The three leading causes of the non-battle air-evacuated TBIs included:
  - Motor vehicle crashes accounted for 29.5 percent of air evacuated non-battle TBIs.
  - Blunt trauma accounted for 17.1 percent of non-battle TBIs necessitating air evacuation.
  - Falls accounted for 16.2 percent of air evacuated non-battle TBIs.

Table 13. Distribution of Types of Motor Vehicle Incidents Resulting in Non-Battle Traumatic Brain Injury (Air Evacuated), 2004-2009<sup>1</sup>

Types of Motor Vehicle Incidents <sup>2</sup>	Air Evacuated	
	n	%
Rollover	38	31.1
Collision	27	22.1
Thrown from vehicle	6	4.9
Pedestrian	4	3.3
Ran off road	3	2.5
Jostled in vehicle	3	2.5
Other <sup>3</sup>	5	4.1
Unspecified	32	26.2
<b>Total</b>	<b>122</b>	<b>100.0</b>

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (OIF and OEF).

<sup>2</sup> Types of motor vehicle incidents resulting in non-battle traumatic brain injury are listed in rank order based on air evacuated traumatic brain injuries.

<sup>3</sup> Other category crushing (n=1), fall from vehicle (n=1), IED (n=1), mechanical failure (n=1), and motorcycle crash (n=1).

- The types of motor vehicle incidents that resulted in TBI (non-battle injuries) were identified from the narrative patient histories in the air evacuation records. The distribution of these motor vehicle incidents is presented in Table 13. This information was not available in the hospitalization records.
- Motor vehicle incidents accounted for 29.5 percent of the air evacuated non-battle TBIs (n=122).
  - Roll-overs accounted for 31.1 percent of air-evacuated non-battle motor vehicle crashes resulting in TBIs.
  - Collisions accounted for an additional 22.1 percent of non-battle motor vehicle crashes resulting in TBIs.
  - The third leading factor associated with TBIs was being thrown from the vehicle accounting for 4.9 percent of cases.

Table 14. Distribution of Fall-Related Causes of Non-Battle Traumatic Brain Injuries (Hospitalized and Air Evacuated), 2004-2009<sup>1,2</sup>

Fall-Related Causes of Injury <sup>3</sup>	Hospitalized		Air Evacuated	
	n	%	n	%
One level to another level	93	54.0	37	54.4
Same Level	69	40.1	21	30.8
Stairs/Ladder	8	4.7	5	7.4
Slips/Trips/Running/Twist	2	1.2	5	7.4
<b>Total</b>	<b>172</b>	<b>100.0</b>	<b>68</b>	<b>100.0</b>

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).

<sup>2</sup> Includes only non-battle Injuries.

<sup>3</sup> Fall-related causes of injury are listed in rank order based on hospitalized traumatic brain injuries.

- Table 14 presents the distribution for the fall-related causes (NBI) of hospitalized and air evacuated TBI.
- As shown in Table 12, falls were a leading cause of non-battle-related TBIs that were hospitalized (20.3 percent) and air evacuated (16.2 percent), and accounted for a total of 240 TBIs.
- Falls from one level to another were the leading fall-related cause of TBI (hospitalizations: 54.0 percent; air evacuations: 54.4 percent).
- Falls on the same level accounted 40.1 percent and 30.8 percent of fall-related TBIs that were hospitalized and air evacuated, respectively.

Table 15. Distribution of Sports and Exercise Activities as Causes of Traumatic Brain Injury (Hospitalized and Air Evacuated), 2004-2009<sup>1</sup>

Sports and Exercise Activity	Hospitalized		Air Evacuated	
	n	%	n	%
American football	17	28.8	9	25.7
Combatives/boxing/wrestling	10	16.9	8	22.9
Basketball	13	22.0	5	14.3
Baseball/softball	8	11.9	2	5.7
Soccer	6	10.2	1	2.9
Calisthenics (PT)	0	0.0	5	14.3
Weightlifting	0	0.0	2	5.7
Other <sup>3,4</sup>	5	10.2	3	8.6
<b>Total</b>	<b>59</b>	<b>100.0</b>	<b>35</b>	<b>100.0</b>

Notes:

<sup>1</sup> Includes traumatic brain injuries from both operations (Operation Iraqi Freedom and Operation Enduring Freedom).

<sup>2</sup> Sports and exercise activities resulting in traumatic brain injury are listed in rank order based on hospitalized traumatic brain injuries.

<sup>3</sup> Other category for hospitalizations includes non-battle injuries caused by other specified sports (n=4) and rock climbing (n=1).

<sup>4</sup> Other category for air-evacuations includes non-battle injuries caused by other specified sports (n=2) and swimming (n=1).

- Table 15 presents the distribution for the types of sports and exercise activities in which Soldiers were participating when they sustained a TBI that required hospitalization or air evacuation.
- As shown in Table 12, sports and physical training were the third leading cause for hospitalized non-battle TBIs (6.9 percent) and the fourth leading cause of air-evacuated non-battle TBIs (7.9 percent).
- Football, basketball, and combatives/boxing/wrestling were the three most frequent activities causing sports-related TBIs, but the rank order and percentage of these activities differed among hospitalized TBIs and air evacuated TBIs. Calisthenics (PT) was also tied for third leading cause of air evacuated TBIs (14.3 percent).

## 7. DISCUSSION.

a. This report describes the incidence and rate of TBIs that were hospitalized in CENTCOM and TBIs that were air evacuated from CENTCOM among Army Soldiers deployed in Iraq and Afghanistan from 2004- 2009. This is the first known report summarizing the battle- and non-battle-related causes of these TBIs.

b. During this timeframe, 2,959 TBI cases were hospitalized in-theater (OIF rate: 31.8 per 10,000 p-years; OEF rate: 48.2 per 10,000 p-years) and 1,917 TBI cases were air evacuated from CENTCOM (OIF rate: 20.7 per 10,000 p-years; OEF rate: 30.9 per 10,000 p-years). These TBI cases accounted for 8.2 percent of all in-theater hospitalizations and 4.7 percent of all medical air evacuations.

c. Of Soldiers who were hospitalized with a TBI, 694 were also air evacuated for a TBI that was recorded in their air evacuation record. Accounting for these TBI cases that were hospitalized and subsequently air evacuated for a TBI (n=694), there were 4,182 unique TBI cases identified among deployed Soldiers from 2004 - 2009. The overall TBI rates for OIF and OEF were 45.3 per 10,000 and 66.4 per 10,000 p-years, respectively.

d. As reported in other studies [10, 15, 16, 17], Soldiers hospitalized or air-evacuated for TBI were overwhelmingly younger than 30 years (hospitalized: 74 percent; air evacuated: 68 percent), male (hospitalized: 98 percent; air evacuated: 97 percent), and E-6 rank or lower rank (hospitalized: 89 percent; air evacuated: 88 percent). While it is clear that male Soldiers make up a larger proportion of deployed Soldiers (90 percent) and, therefore, would account for a larger proportion of TBI cases, it is also true that the percentages of males that were hospitalized or air evacuated with TBI were significantly higher than the percentage of males deployed, illustrating that deployed males have disproportionately higher incidence of TBI ( $p<.01$ ). This difference in TBI incidence can be explained in part by the differing roles of males and females in combat. But this finding of higher incidence among males has also been reported for the U.S. civilian population, where the number of men treated for TBI is nearly twice as high as the number of women [8, 18].

e. When comparing the hospitalized TBIs (n=2,959) to the air evacuated TBIs (n=1,917), differences were noted in the severity and functional categories, and in the final injury outcomes. Understanding these differences allows a greater recognition of the overall impact that TBIs have on the medical treatment facilities in theater and on the medical air evacuation system. Of the hospitalized TBIs, 14 percent died prior to or during their hospitalization, 23 percent were air evacuated for the TBI, and 18 percent were air evacuated for other more serious injuries. TBIs in these categories were the

most serious injuries and included 93 percent of all penetrating TBIs and 97 percent of all severe TBIs, but only 7 percent of the TBIs with a postconcussion syndrome (functional category). Of the hospitalized TBIs, 43% were discharged and returned to duty in CENTCOM. As would be expected, these TBIs tended to be less severe injuries with 90 percent being mild TBIs and 10 percent being moderate TBIs. TBIs that were air evacuated without having been hospitalized (n=1,223) were mild (84 percent) or moderate TBIs (15 percent), and included 86 percent of all TBIs categorized as postconcussion syndrome (functional category).

f. Annual TBI rates for OIF and OEF (Figures 2, 4, and 6) peaked in 2007 and 2009, respectively. These higher rates were due primarily to higher rates for battle-related TBI in these periods (Figures 3a, 3b, 5a, 5b, 7a, and 7b). These yearly rates follow the same trends as 1) the number of at-risk Soldiers who were deployed each year for each operation (Appendix E) and 2) the annual rates for wounded-in-action and fatal battle injury (Appendix F). The higher TBI rates for OEF compared to OIF may reflect differences in the types of operations conducted in Afghanistan and Iraq, with greater dependence on dismounted patrols in Afghanistan. The 2007 peak in the battle-related TBI rate for OIF was previously noted by Heltemes et al. [15]. With increasing awareness and concern for TBIs and improvements in TBI surveillance, screening, and evaluation [2, 10, 15, 16], one might expect that TBI rates would trend higher over time based solely on this surveillance effect, but it is clear from data presented in this report that other factors are primarily affecting TBI rates for OIF and OEF.

g. An important aspect of this analysis was to describe the leading causes of TBI among deployed Soldiers. Battle-related TBI accounted for 22.3 percent of all hospitalized BIs and 16.0 percent of all air evacuated BIs. Two-thirds of both hospitalized and air evacuated TBIs were battle-related injuries. The leading causes of battle-related TBIs were shrapnel/fragments (hospitalized TBIs) and IEDs (air evacuated TBIs). Other studies [10, 16, 17, 19] have reported the three leading causes of battle-related hospitalized TBIs to be IED, grenades, other weapons, and bullets. However, the current report found the leading causes of battle-related hospitalized TBIs to be shrapnel/shell fragments, other conventional weapons, and bullets. The leading causes of battle-related air evacuated TBIs were IED/mine/bombs, grenades, and bullets. These differences in the leading causes of battle-related TBIs (hospitalized versus air evacuated) most likely stem from differences in the amount of detail available in the hospitalization and air evacuation records. It is likely that the majority of the air evacuated TBIs cases that were cause coded as IED/mine/bomb actually resulted from the shrapnel that occurred from the blast. However, if that information was not specified in the patient history, the cause of injury could only be categorized as IED.

h. Though not often recognized, one-quarter of deployment-related TBIs were from non-battle causes in injury. For hospitalized TBIs and air evacuated TBIs, the leading

causes of non-battle-related TBIs were the same four activities: motor vehicle incidents, falls, sports/PT, and blunt trauma. These findings echo those reported for civilian populations (that is, motor vehicle incidents, falls, and blunt trauma) [8]. Approximately three-fourths of the air evacuated motor vehicle-related TBIs with a reported contributing factor were due to rollover of a military vehicle or collision with a vehicle or other object. Falls were another leading cause of non-battle-related TBI. For both hospitalized TBIs and air evacuated TBIs, most non-battle fall-related TBIs were caused by falls from one level to another and falls occurring on the same level. Sports-related TBIs most often occurred while playing football or basketball, or while engaging in combatives/boxing/wrestling for hospitalized TBIs and air evacuated TBIs.

i. A unique feature of this current analysis was the use of hospitalization and air evacuation records to identify and describe TBI cases among Soldiers deployed for OIF and OEF during 2004-2009. These findings allowed a detailed assessment of the incidence, rate, and causes of hospitalized TBIs and air evacuated TBIs. These TBIs were described separately to 1) highlight the overall impact of TBI on hospitalizations and air evacuations and 2) describe differences in the types of TBI (casualty type, severity category, and functional category) that are hospitalized or air evacuated. But the overall TBI incidence (unique TBI cases) was also reported. This latter approach better represents the actual TBI incidence among the deployed Army population.

j. Comparison of these results to other TBI reports can be difficult due to differences in methodology and study design. Past studies of TBI among military populations have reported TBI incidence ranging from 10 percent to nearly 40 percent depending on the military population [2-4]. Both objective (medical records, screenings, etc.) and subjective (self-report surveys) measures have been used to estimate the incidence of TBI in the military population. Even when objective measures are used to identify TBI incidence, the records and methods vary from one study to another. Caution is, therefore, required when comparing findings from different reports.

k. Results from this report can be compared to two prior reports that also used hospitalization records [15, 16]. Wojcik and colleagues published a study in 2010 utilizing the in-theater hospitalization records to identify TBIs among Soldiers deployed for OIF and OEF. The hospitalized TBI rates presented in this current report (OIF: 31.8 per 10,000 deployed p-years; OEF: 48.2 per 10,000 deployed p-years) are different when compared to Wojcik's findings (OIF: 41.8 per 10,000 deployed p-years; OEF: 24.6 per 10,000 soldier-years) [16]. However, these differences can be attributed to the dates of data collection for each study. Wojcik's data collection period ranged from September 2001-September 2007; whereas, the current report collected data from January 2004 to December 2009. Subsequent to 2007, annual rates of hospitalized TBIs in both operations changed substantially. A sharp increase of the hospitalized TBI

was noted in OEF while the rate decreased in OIF. These changes in annual rates may account for the discrepancies noted in overall rates of hospitalized TBIs between Wojcik's finding and this report.

l. Heltemes' study also utilized in-theater hospitalization records to identify TBI among the deployed military population (rate: 10.4 TBIs per 10,000 troop strength), but direct comparison is limited since Heltemes' included battle-related TBIs among all service members deployed for OIF and OEF from 2003 to 2008 [15]. This current report provides TBI rates for each operation among deployed Army Soldiers. These differences do not allow for a direct comparison of rates to be made. However, both studies noted the sharp increase in battle-related TBIs among Service members in 2007.

m. Similar issues regarding comparison of findings exist when examining the report by MacGregor and colleagues that describes TBI rates during a six month period from September 2004 - February 2005 [17]. That report utilized a deployment health database capturing service member medical encounters, and found that 50.8 percent of battle-related injuries among males (all military branches) in OIF involved a head injury. This report found that approximately 16 percent of battle-related injuries during deployment were diagnosed as TBI.

n. There is greater agreement among studies pertaining to the leading causes of TBI and the sub-populations within the military that have higher TBI incidence. Improvised explosive devices and other blast related exposures have been identified by many studies as a leading cause of battle-related TBIs [10, 16, 17, 19]. Other non-battle causes of TBI among the military population included motor vehicle accidents, falls, blunt objects, and sports [10, 19], which correspond to leading causes of TBI among the civilian population [8]. In addition, several studies supported the current findings indicating that younger, junior enlisted males are more likely to experience TBI than other military personnel [10, 15, 16, 17].

o. Although this report summarizes important TBI surveillance information regarding the incidence and rate of hospitalized TBIs and air evacuated TBIs, there are limitations. The records analyzed in this assessment were not collected for the purposes of this report. These records came from two different sources, in-theater hospitalization records and air evacuation records, with differing collection and coding protocols. Overlap of reported TBI cases between these sources is present as the hospitalization and air evacuation records are not mutually exclusive (n=694). The differences of the two record sources also lead to some discrepancy in the way cases were coded and also in the information available for analysis. However, using hospitalization and air evacuation records to identify TBI cases allowed for a more complete reporting of

incident cases. Had only the hospitalization records been used, 1,123 air evacuated TBIs would have been missed. Conversely, 2,265 hospitalized TBI cases would have been missed if only air evacuation records had been used.

p. The current report identified TBI cases from diagnosis codes (ICD-9-CM) reported in hospitalization records or air evacuation records. However, incidence of TBI may still be under reported, especially for mild TBI cases that did not require hospitalization or air evacuation. Fatalities resulting from TBI may also be underreported if a SIDR record was not created. Furthermore, injury severity could create a bias when coding multiple injuries. While multiple ICD-9-CM codes can be recorded in the hospitalization and air evacuation records, TBIs and less severe injuries are likely to not be reported when multiple traumas have occurred. Injuries that are recorded in theater medical records will be the most life threatening injuries, while injuries that do not require urgent medical attention may not be listed in the hospitalization or air evacuation records. This explains why some of the hospitalized TBI cases that had multiple serious injuries were not documented as TBIs in the air evacuation records. Supporting this, Drake reported that 71 percent of Marines who tested positive for TBI when screened after returning home from theater had not been previously diagnosed with the TBI [20]. Based on those findings, the true incidence of TBI in the military population may be much greater than reported in past research.

## 8. CONCLUSIONS.

a. From 2004 to 2009, 2,959 Soldiers with TBI were hospitalized in CENTCOM and 1,917 Soldiers with TBI cases were medically air evacuated from CENTCOM. Of Soldiers hospitalized for TBI, 694 were also air evacuated for the same TBI. Accounting for these 694 cases, there was a total of 4,182 Soldiers with incident TBIs (hospitalized and/or air evacuated).

b. The OIF and OEF rates for incident TBIs were 45 per 10,000 person [p]-years [yrs] and 66 per 10,000 p-yrs, respectively ( $p < .01$ ). The rates for hospitalized TBIs (OIF: 32 per 10,000 p-yrs; OEF: 48 per 10,000 p-yrs) were higher than rates for air evacuated TBIs (OIF: 21 per 10,000 p-yrs; OEF: 31 per 10,000 p-yrs). Overall, TBI rates were higher for OEF.

c. Incident TBI rates for OIF were highest in 2007 (92 per 10,000 p-yrs.) The higher rate was influenced primarily by a higher rate for battle-related TBIs (64 per 10,000 p-yrs) and to a lesser extent by a higher rate for non-battle-related TBIs (26 per 10,000 p-yrs).

d. Incident TBI rates for OEF increased in 2007 (75 per 10,000 p-yrs) and increased much more sharply in 2009 (115 per 10,000 p-yrs.) The higher OEF rate for 2009 was

primarily influenced by the much higher rate for battle-related TBIs (91 per 10,000 p-yrs).

e. Battle injuries accounted for 69 percent of hospitalized TBIs and 65 percent of air evacuated TBIs. The leading causes of battle-related TBI included shrapnel/shell fragments (59 percent of the hospitalized battle-related TBIs) and IED/mine/bombs (79 percent of the air evacuated battle-related TBIs).

f. TBIs that were non-battle injuries (that is, not caused by hostile or enemy activity) comprised 29 percent of hospitalized TBIs and 22 percent of air evacuated TBIs. The leading non-battle causes of hospitalized TBIs and air evacuated TBIs were motor vehicle crashes (42 percent and 30 percent, respectively), falls (20 percent and 16 percent, respectively), sports/PT (7 percent and 8 percent, respectively), and blunt trauma (5 percent and 17 percent, respectively).

## 9. RECOMMENDATIONS.

a. Considering that one-quarter of deployment-related TBIs result from non-battle causes, increase TBI surveillance and research efforts to identify potentially modifiable risk factors for leading non-battle causes of TBI (motor vehicle mishaps, falls, sport/exercise, and blunt trauma).

b. Though documentation of TBI in the deployment electronic medical records has greatly improved, increased emphasis is required to 1) document TBI incident cases at all levels of deployed medical care and 2) identify and track Soldiers who are at greatest risk for TBI.

c. Conduct surveillance, epidemiologic analysis, and research to identify the incidence of TBI among Soldiers and to evaluate the potential increased risk associated with having a subsequent TBI among Soldiers who have had a prior TBI.

d. Conduct epidemiologic analysis and research to identify the long-term effects and potential modifiable risk factors for disability among Soldiers who have had one or more TBI.

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## APPENDIX A

### REFERENCES

1. Defense and Veterans Brain Injury Center, <http://www.dvbic.org/TBI-Numbers.aspx>, accessed 30 December 2011.
2. Hoge, C.W., et al. 2008. Mild traumatic brain injury in U.S. Soldiers returning from Iraq. *N Engl J Med*, 358(5): p. 453-63.
3. Terrio, H., et al. 2009. Traumatic brain injury screening: preliminary findings in a U.S. Army Brigade Combat Team. *J Head Trauma Rehabil*, 24(1): p. 14-23.
4. Colombo, C.J., C.A. Mount, and C.A. Popa. 2008. Critical care medicine at Walter Reed Army Medical Center in support of the global war on terrorism. *Crit Care Med*, 36(7 Suppl): p. S388-94.
5. Institute of Medicine. 2009. Committee on Gulf War and Health: Brain Injury in Veterans and Long-Term Health Outcomes. *Gulf War and Health 2009. Volume 7: Long-term Consequences of Traumatic Brain Injury*. Washington DC: National Academies Press, 2009.
6. Blackman, E.G., M.E. Hale, S.H. Lisanby. 2007. *Improving TBI protection measures and standards for combat helmets*. Defense Science Study Group paper, Section 3.3.5.
7. Walter Reed Army Medical Center. 2008. Defense and Veterans Brain Injury Center Working Group. *Consensus conference on the on the acute management of concussion/mild traumatic brain injury (mTBI) in deployed settings*. Washington, D.C: Defense and Veterans Brain Injury Center. Available from: <http://www.dvbic.org/images/pdfs/>.
8. Faul, M., L. Xu, M.M. Wald, and V. Coronado. 2010. *Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths, 2002-2006*. Atlanta, GA: Center for Disease Control and Prevention, National Center for Injury Prevention and Control.
9. Ritenour, A.E. and T.W. Baskin. 2008. Primary blast injury: update on diagnosis and treatment. *Crit Care Med*, 36(7 Suppl): p. S311-7.

10. Galarneau, M.R., et al., 2008. Traumatic brain injury during Operation Iraqi Freedom: findings from the United States Navy-Marine Corps Combat Trauma Registry. *J Neurosurg*, 108(5): p. 950-7.
11. Armed Forces Health Surveillance Center. 2008. Frequencies, Rates, and Trends of use of Diagnosis Codes Indicative of Traumatic Brain Injury (TBI), July 1999-June 2008. *MSMR*, 15(10). p. 2-9.
12. Wojcik, B., C. Stein, J. Orosco, K. Bagg, and R. Humphrey. 2010. Creation of an expanded Barell matrix to identify traumatic brain injury of U.S. Military members. *Journal of Defense Modeling and Simulation: Application, Methodology, Technology*, 7(3). p. 157-166.
13. Barell, V., L. Aharonson-Daniel, L.A. Fingerhut, et al. 2002. An introduction to the Barell body region by nature of injury diagnosis matrix. *Injury Prevention*, 8(2). p. 91-96.
14. North Atlantic Treaty Organization Standardization Agreement 2050. 1989. In: Statistical Classification of Diseases, Injuries and Causes of Death. 5th ed. Brussels: NATO.
15. Heltemes, K.J., A.L. Dougherty, A.J. MacGregor, and M.R. Galarneau. 2011. Inpatient hospitalizations of U.S. military personnel medically evacuated from Iraq and Afghanistan with combat-related traumatic brain injury. *Mil Med*, 176(2): p. 132- 135.
16. Wojcik, B.E., C.R. Stein, K. Bagg, R. Humphrey, and J. Orosco. 2010. Traumatic brain injury hospitalizations of U.S. Army Soldiers deployed to Afghanistan and Iraq. *American Journal of Preventive Medicine.*, 38(1S): p. S108-S116.
17. MacGregor, A.J., R.A. Schaffer, A.L. Dougherty, M.R. Galarneau, R. Raman, D.G. Baker, S.P. Lindsay, B.A. Golomb, and K.S. Corson. 2010. Prevalence and psychological correlates of traumatic brain injury in Operation Iraqi Freedom. *Journal of Head Trauma Rehabilitation*, 25(1). p: 1-8.
18. Coronado, V.G., L. Xu, L.C. McGuire, M.M. Wald, M.D. Faul, B.R. Guzman, and J.D. Hemphill. 2011. Surveillance for traumatic brain injury- Related deaths- United States, 1997-2007. *Morbidity and Mortality Weekly Report*, 60(SS05): p. 1-32.

19. Schneiderman, A.I., E.R. Braver, and H.K. Kang. 2008. Understanding sequelae of injury mechanisms and mild traumatic brain injury incurred during the conflicts in Iraq and Afghanistan: persistent postconcussive symptoms and posttraumatic stress disorder. *American Journal of Epidemiology*, 167(12). p: 1446-1452.
20. Drake, A.I., K.S. Meyer, L.M. Cessante, C.R. Cheung, M.A. Cullen, E.C. McDonald, and M.C. Holland. 2010. Routine TBI screening following combat deployments. *NeuroRehabilitation*, 26. p: 183-189.

## APPENDIX B

DEFENSE AND VETERANS BRAIN INJURY CENTER ICD-9-CM CODES  
USED FOR TBI CASE DEFINITION

Condition	ICD-9-CM Codes	ICD-9-CM Diagnosis
Traumatic Brain Injury (TBI)	310.2	postconcussion syndrome
	800.0x – 800.9x	fracture of vault of skull
	801.0x – 801.9x	fracture of base of skull
	803.0x – 803.9x	other and unqualified skull fractures
	804.0x – 804.9x	multiple fractures involving skull or face with other bones
	850.x	concussion
	851.0x – 851.9x	cerebral laceration and contusion
	852.0x – 852.5x	subarachnoid, subdural, and extradural hemorrhage, following injury
	853.0x – 853.1x	other and unspecified intracranial hemorrhage following injury
	854.0x – 854.1x	intracranial injury of other and unspecified nature
	907	late effect of intracranial injury without skull or facial fracture
	950.1 - 950.3	injury to optic chiasm/pathways or visual cortex
	959.01	head injury, unspecified
	<b>V- Codes</b>	<b>Personal History of TBI</b>
	V15.52	
	V15.52_0 - V15.52_9	
	V15.52_A - V15.52_F	
	V15.5_1 - V15.5_9*	
	V15.5_A - V15.5_F*	
	V15.59_1 - V15.59_9*	
	V15.59_A - V15.59_F*	

## Notes:

<sup>1</sup> ICD-9-CM code 995.55 (shaken infant syndrome) is included in the standard Defense and Veterans Brain Injury Center traumatic brain injury case definition in an effort to be consistent with the CDC. This code is not used by Armed Forces Health Surveillance Center as it is not relevant to military surveillance objectives.

<sup>2</sup> Case definition and ICD-9-CM codes are based on "traumatic brain injury: Appendix F-G dated 5/1/10 and Appendix 7 dated 2/26/10: from Military Health System Coding Guidance: Professional Services and Specialty Coding Guidelines (Version 3.2) by the Unified Biostatistical Utility working group.

\* V codes: V15.52\_1 thru V15.52\_9 and V15.52\_A thru V15.52\_F were *added* to the surveillance case definition. These codes replaced the V15.5 and the V15.59 series. V codes V15.5\_1 thru V15.5\_9 and V15.59\_A thru V15.59\_F are no longer included in the ICD9 coding system. However, the V15.5 and V15.59 series codes are included in the surveillance case definition for analyses using data from 2010 and prior.

Source: Armed Forces Health Surveillance Center. Traumatic Brain Injury TBI. AFHSC Surveillance Case Definitions Final November 2011.

APPENDIX C  
DEFENSE AND VETERANS BRAIN INJURY CENTER'S SEVERITY CLASSIFICATIONS FOR ICD-9-CM CODES

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
800.0	Fracture of Vault of Skull-Closed w/o mention of intracranial injury						
xxx.00		x		x			
xxx.01		x		x			
xxx.02		x		x			
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x		x			
xxx.09		x		x			
800.1	Fracture of Vault of Skull-Closed w/ cerebral laceration and contusion						
xxx.10		x			x		
xxx.11		x			x		
xxx.12		x			x		
xxx.13		x			x		
xxx.14		x				x	
xxx.15		x				x	
xxx.16		x			x		
xxx.19		x			x		
800.2	Fracture of Vault of Skull-Closed w/ subarachnoid, subdural and extradural hemorrhage						
xxx.20		x			x		
xxx.21		x			x		
xxx.22		x			x		
xxx.23		x			x		
xxx.24		x				x	
xxx.25		x				x	
xxx.26		x			x		
xxx.29		x			x		
800.3	Fracture of Vault of Skull-Closed w/ other unspecified intracranial hemorrhage						
xxx.30		x			x		
xxx.31		x			x		
xxx.32		x			x		
xxx.33		x			x		
xxx.34		x				x	
xxx.35		x				x	
xxx.36		x			x		
xxx.39		x			x		
800.4	Fracture of Vault of Skull-Close w/ intracranial injury of other and unspecified nature						
xxx.40		x			x		

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.41		x			x		
xxx.42		x			x		
xxx.43		x			x		
xxx.44		x				x	
xxx.45		x				x	
xxx.46		x			x		
xxx.49		x			x		
800.5	Fracture of Vault of Skull-Open w/o mention of intracranial injury						
xxx.50		x		x			
xxx.51		x		x			
xxx.52		x		x			
xxx.53		x			x		
xxx.54		x				x	
xxx.55		x				x	
xxx.56		x			x		
xxx.59		x			x		
800.6	Fracture of Vault of Skull-Open w/ cerebral laceration and contusion						
xxx.60			x				
xxx.61			x				
xxx.62			x				
xxx.63			x				
xxx.64			x				
xxx.65			x				
xxx.66			x				
xxx.69			x				
800.7	Fracture of Vault of Skull-Open w/ subarachnoid, subdural and extradural hemorrhage						
xxx.70			x				
xxx.71			x				
xxx.72			x				
xxx.73			x				
xxx.74			x				
xxx.75			x				
xxx.76			x				
xxx.79			x				
800.8	Fracture of Vault of Skull-Open w/ other unspecified intracranial hemorrhage						
xxx.80			x				
xxx.81			x				
xxx.82			x				
xxx.83			x				
xxx.84			x				
xxx.85			x				
xxx.86			x				

Injury Prevention Report No. 12-HF-0F3E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.89			x				
800.9	Fracture of Vault of Skull-Open w/ intracranial injury of other and unspecified nature						
xxx.90			x				
xxx.91			x				
xxx.92			x				
xxx.93			x				
xxx.94			x				
xxx.95			x				
xxx.96			x				
xxx.99			x				
801.0	Fracture of Base of Skull-Closed w/o mention of intracranial injury						
xxx.00		x		x			
xxx.01		x		x			
xxx.02		x		x			
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x		x			
xxx.09		x		x			
801.1	Fracture of Base of Skull-Closed w/cerebral laceration and contusion						
xxx.10		x			x		
xxx.11		x			x		
xxx.12		x			x		
xxx.13		x			x		
xxx.14		x				x	
xxx.15		x				x	
xxx.16		x			x		
xxx.19		x			x		
801.2	Fracture of Base of Skull-Closed w/ subarachnoid, subdural and extradural hemorrhage						
xxx.20		x			x		
xxx.21		x			x		
xxx.22		x			x		
xxx.23		x			x		
xxx.24		x				x	
xxx.25		x				x	
xxx.26		x			x		
xxx.29		x			x		
801.3	Fracture of Base of Skull-Closed w/ other and unspecified intracranial hemorrhage						
xxx.30		x			x		
xxx.31		x			x		
xxx.32		x			x		

Injury Prevention Report No. 12-HF-0F4E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.33		x			x		
xxx.34		x				x	
xxx.35		x				x	
xxx.36		x			x		
xxx.39		x			x		
801.4	Fracture of Base of Skull-Closed w/ intracranial injury of other and unspecified nature						
xxx.40		x			x		
xxx.41		x			x		
xxx.42		x			x		
xxx.43		x			x		
xxx.44		x				x	
xxx.45		x				x	
xxx.46		x			x		
xxx.49		x			x		
801.5	Fracture of Base of Skull-Open w/o mention of intracranial injury						
xxx.50		x		x			
xxx.51		x		x			
xxx.52		x		x			
xxx.53		x			x		
xxx.54		x				x	
xxx.55		x				x	
xxx.56		x			x		
xxx.59		x			x		
801.6	Fracture of Base of Skull-Open w/ cerebral laceration and contusion						
xxx.60			x				
xxx.61			x				
xxx.62			x				
xxx.63			x				
xxx.64			x				
xxx.65			x				
xxx.66			x				
xxx.69			x				
801.7	Fracture of Base of Skull-Open w/ subarachnoid, subdural and extradural hemorrhage						
xxx.70			x				
xxx.71			x				
xxx.72			x				
xxx.73			x				
xxx.74			x				
xxx.75			x				
xxx.76			x				
xxx.79			x				

Injury Prevention Report No. 12-HF-0F5E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
801.8	Fracture of Base of Skull-Open w/ other and unspecified intracranial hemorrhage						
xxx.80			x				
xxx.81			x				
xxx.82			x				
xxx.83			x				
xxx.84			x				
xxx.85			x				
xxx.86			x				
xxx.89			x				
801.9	Fracture of Base of Skull-Open w/ intracranial injury of other and unspecified nature						
xxx.90			x				
xxx.91			x				
xxx.92			x				
xxx.93			x				
xxx.94			x				
xxx.95			x				
xxx.96			x				
xxx.99			x				
803.0	Closed Skull Fracture without mention of intracranial injury						
xxx.00		x		x			
xxx.01		x		x			
xxx.02		x		x			
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x		x			
xxx.09		x		x			
803.1	Closed Skull Fracture with cerebral laceration and contusion						
xxx.10		x			x		
xxx.11		x			x		
xxx.12		x			x		
xxx.13		x			x		
xxx.14		x				x	
xxx.15		x				x	
xxx.16		x			x		
xxx.19		x			x		
803.2	Closed Skull Fracture with subarachnoid, subdural, and extradural hemorrhage						
xxx.20		x			x		
xxx.21		x			x		
xxx.22		x			x		
xxx.23		x			x		

Injury Prevention Report No. 12-HF-0F6E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.24		x				x	
xxx.25		x				x	
xxx.26		x			x		
xxx.29		x			x		
803.3	Closed Skull Fracture with other and unspecified intracranial hemorrhage						
xxx.30		x			x		
xxx.31		x			x		
xxx.32		x			x		
xxx.33		x			x		
xxx.34		x				x	
xxx.35		x				x	
xxx.36		x			x		
xxx.39		x			x		
803.4	Closed Skull Fracture with intracranial injury of other and unspecified nature						
xxx.40		x			x		
xxx.41		x			x		
xxx.42		x			x		
xxx.43		x			x		
xxx.44		x				x	
xxx.45		x				x	
xxx.46		x			x		
xxx.49		x			x		
803.5	Open Skull Fracture without mention of intracranial injury						
xxx.50		x		x			
xxx.51		x		x			
xxx.52		x		x			
xxx.53		x			x		
xxx.54		x				x	
xxx.55		x				x	
xxx.56		x			x		
xxx.59		x			x		
803.6	Open Skull Fracture with cerebral laceration and contusion						
xxx.60			x				
xxx.61			x				
xxx.62			x				
xxx.63			x				
xxx.64			x				
xxx.65			x				
xxx.66			x				
xxx.69			x				
803.7	Open Skull Fracture with subarachnoid, subdural, and extradural hemorrhage						

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.70			x				
xxx.71			x				
xxx.72			x				
xxx.73			x				
xxx.74			x				
xxx.75			x				
xxx.76			x				
xxx.79			x				
803.8	Open Skull Fracture with other and unspecified intracranial hemorrhage						
xxx.80			x				
xxx.81			x				
xxx.82			x				
xxx.83			x				
xxx.84			x				
xxx.85			x				
xxx.86			x				
xxx.89			x				
803.9	Open Skull Fracture with intracranial injury of other and unspecified nature						
xxx.90			x				
xxx.91			x				
xxx.92			x				
xxx.93			x				
xxx.94			x				
xxx.95			x				
xxx.96			x				
xxx.99			x				
804.0	Closed Skull Fracture without mention of intracranial injury						
xxx.00		x		x			
xxx.01		x		x			
xxx.02		x		x			
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x		x			
xxx.09		x		x			
804.1	Closed Skull Fracture with cerebral laceration and contusion						
xxx.10		x			x		
xxx.11		x			x		
xxx.12		x			x		
xxx.13		x			x		
xxx.14		x				x	
xxx.15		x				x	

Injury Prevention Report No. 12-HF-0F8E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.16		x			x		
xxx.19		x			x		
804.2	Closed Skull Fracture with subarachnoid, subdural, and extradural hemorrhage						
xxx.20		x			x		
xxx.21		x			x		
xxx.22		x			x		
xxx.23		x			x		
xxx.24		x				x	
xxx.25		x				x	
xxx.26		x			x		
xxx.29		x			x		
804.3	Closed Skull Fracture with other and unspecified intracranial hemorrhage						
xxx.30		x			x		
xxx.31		x			x		
xxx.32		x			x		
xxx.33		x			x		
xxx.34		x				x	
xxx.35		x				x	
xxx.36		x			x		
xxx.39		x			x		
804.4	Closed Skull Fracture with intracranial injury of other and unspecified nature						
xxx.40		x			x		
xxx.41		x			x		
xxx.42		x			x		
xxx.43		x			x		
xxx.44		x				x	
xxx.45		x				x	
xxx.46		x			x		
xxx.49		x			x		
804.5	Open Skull Fracture without mention of intracranial injury						
xxx.50		x		x			
xxx.51		x		x			
xxx.52		x		x			
xxx.53		x			x		
xxx.54		x				x	
xxx.55		x				x	
xxx.56		x			x		
xxx.59		x			x		
804.6	Open Skull Fracture with cerebral laceration and contusion						
xxx.60			x				
xxx.61			x				

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.62			x				
xxx.63			x				
xxx.64			x				
xxx.65			x				
xxx.66			x				
xxx.69			x				
804.7	Open Skull Fracture with subarachnoid, subdural, and extradural hemorrhage						
xxx.70			x				
xxx.71			x				
xxx.72			x				
xxx.73			x				
xxx.74			x				
xxx.75			x				
xxx.76			x				
xxx.79			x				
804.8	Open Skull Fracture with other and unspecified intracranial hemorrhage						
xxx.80			x				
xxx.81			x				
xxx.82			x				
xxx.83			x				
xxx.84			x				
xxx.85			x				
xxx.86			x				
xxx.89			x				
804.9	Open Skull Fracture with intracranial injury of other and unspecified nature						
xxx.90			x				
xxx.91			x				
xxx.92			x				
xxx.93			x				
xxx.94			x				
xxx.95			x				
xxx.96			x				
xxx.99			x				
850	Concussion	x		x			
xxx.0	With no loss of consciousness	x		x			
850.1	with brief loss of consciousness	x		x			
xxx.11	with loss of consciousness of 30 minutes or less	x		x			
xxx.12	with loss of consciousness of from 31 to 59 minutes	x			x		
850.2	with moderate loss of consciousness (loss of consciousness for 1-24 hours)	x			x		

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
850.3	with prolonged loss of consciousness and return to pre-existing conscious level (loss of consciousness for more than 24 hours with complete recovery)	x				x	
850.4	with prolonged loss of consciousness, without return to pre-existing conscious level	x				x	
850.5	with loss of consciousness for unspecified duration	x		x			
850.9	concussion, unspecified	x		x			
851.0	Cerebral laceration and contusion-Cortex (cerebral) contusion w/o mention of open intracranial wound						
xxx.00		x			x		
xxx.01		x			x		
xxx.02		x			x		
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x			x		
xxx.09		x			x		
851.1	Cerebral laceration and contusion-Cortex (cerebral) contusion w/ open intracranial wound						
xxx.10			x				
xxx.11			x				
xxx.12			x				
xxx.13			x				
xxx.14			x				
xxx.15			x				
xxx.16			x				
xxx.19			x				
851.2	Cerebral laceration and contusion-Cortex (cerebral) laceration w/o mention of open intracranial wound						
xxx.20		x			x		
xxx.21		x			x		
xxx.22		x			x		
xxx.23		x			x		
xxx.24		x				x	
xxx.25		x				x	
xxx.26		x			x		
xxx.29		x			x		
851.3	Cerebral laceration and contusion-Cortex (cerebral) laceration w/ open intracranial wound						
xxx.30			x				
xxx.31			x				
xxx.32			x				
xxx.33			x				
xxx.34			x				

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
xxx.35			x				
xxx.36			x				
xxx.39			x				
851.4	Cerebral laceration and contusion-Cerebellar or brain stem contusion w/o mention of open intracranial wound						
xxx.40		x			x		
xxx.41		x			x		
xxx.42		x			x		
xxx.43		x			x		
xxx.44		x				x	
xxx.45		x				x	
xxx.46		x			x		
xxx.49		x			x		
851.5	Cerebral laceration and contusion-Cerebellar or brain stem contusion w/ open intracranial wound						
xxx.50			x				
xxx.51			x				
xxx.52			x				
xxx.53			x				
xxx.54			x				
xxx.55			x				
xxx.56			x				
xxx.59			x				
851.6	Cerebral laceration and contusion-Cerebellar or brain stem laceration w/o mention of open intracranial wound						
xxx.60		x			x		
xxx.61		x			x		
xxx.62		x			x		
xxx.63		x			x		
xxx.64		x				x	
xxx.65		x				x	
xxx.66		x			x		
xxx.69		x			x		
851.7	Cerebral laceration and contusion-Cerebellar or brain stem laceration w/ open intracranial wound						
xxx.70			x				
xxx.71			x				
xxx.72			x				
xxx.73			x				
xxx.74			x				
xxx.75			x				
xxx.76			x				
xxx.79			x				

Injury Prevention Report No. 12-HF-0F12E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
851.8	Cerebral laceration and contusion-Other and unspecified cerebral laceration and contusion, w/o mention of open intracranial wound						
xxx.80		x			x		
xxx.81		x			x		
xxx.82		x			x		
xxx.83		x			x		
xxx.84		x				x	
xxx.85		x				x	
xxx.86		x			x		
xxx.89		x			x		
851.9	Cerebral laceration and contusion-Other and unspecified cerebral laceration and contusion, w/ open intracranial wound						
xxx.90			x				
xxx.91			x				
xxx.92			x				
xxx.93			x				
xxx.94			x				
xxx.95			x				
xxx.96			x				
xxx.99			x				
852.0	Subarachnoid, Subdural, and Extradural hemorrhage following injury Subarachnoid hemorrhage following injury w/o mention of open intracranial wound, middle meningeal hemorrhage following injury						
xxx.00		x			x		
xxx.01		x			x		
xxx.02		x			x		
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x			x		
xxx.09		x			x		
852.1	Subarachnoid, Subdural, and Extradural hemorrhage following injury- Subarachnoid hemorrhage following injury w/ open intracranial wound						
xxx.10			x				
xxx.11			x				
xxx.12			x				
xxx.13			x				
xxx.14			x				
xxx.15			x				
xxx.16			x				
xxx.19			x				

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
852.2	Subarachnoid, Subdural, and Extradural hemorrhage following injury-Subdural hemorrhage following injury w/o mention of open intracranial wound						
xxx.20		x			x		
xxx.21		x			x		
xxx.22		x			x		
xxx.23		x			x		
xxx.24		x				x	
xxx.25		x				x	
xxx.26		x			x		
xxx.29		x			x		
852.3	Subarachnoid, Subdural, and Extradural hemorrhage following injury-Subdural hemorrhage following injury w/ open intracranial wound						
xxx.30			x				
xxx.31			x				
xxx.32			x				
xxx.33			x				
xxx.34			x				
xxx.35			x				
xxx.36			x				
xxx.39			x				
852.4	Subarachnoid, Subdural, and Extradural hemorrhage following injury-Extradural hemorrhage following injury w/o mention of open intracranial wound. Epidural hematoma following injury						
xxx.40					x		
xxx.41					x		
xxx.42					x		
xxx.43					x		
xxx.44						x	
xxx.45						x	
xxx.46					x		
xxx.49					x		
852.5	Subarachnoid, Subdural, and Extradural hemorrhage following injury-Extradural hemorrhage following injury w/ open intracranial wound						
xxx.50			x				
xxx.51			x				
xxx.52			x				
xxx.53			x				
xxx.54			x				
xxx.55			x				
xxx.56			x				
xxx.59			x				

Injury Prevention Report No. 12-HF-0F14E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
853.0	Other and unspecified intracranial hemorrhage following injury-W/o mention of open intracranial wound, cerebral compression due to injury, intracranial hematoma following injury, traumatic cerebral hemorrhage						
xxx.00		x			x		
xxx.01		x			x		
xxx.02		x			x		
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x			x		
xxx.09		x			x		
853.1	Other and unspecified intracranial hemorrhage following injury-W/ open intracranial wound						
xxx.10			x				
xxx.11			x				
xxx.12			x				
xxx.13			x				
xxx.14			x				
xxx.15			x				
xxx.16			x				
xxx.19			x				
854.0	Intracranial Injury of other and unspecified nature-W/o mention of open intracranial wound						
xxx.00		x			x		
xxx.01		x			x		
xxx.02		x			x		
xxx.03		x			x		
xxx.04		x				x	
xxx.05		x				x	
xxx.06		x			x		
xxx.09		x			x		
854.1	Intracranial Injury of other and unspecified nature-W/ open intracranial wound						
xxx.10			x				
xxx.11			x				
xxx.12			x				
xxx.13			x				
xxx.14			x				
xxx.15			x				
xxx.16			x				
xxx.19			x				
310.2	post concussion syndrome	x		x			
950.1	Injury to optic chiasm						x

Injury Prevention Report No. 12-HF-0F15E-09, 01 Jan 2004-31 Dec 2009

ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
950.2	Injury to optic pathways						x
950.3	Injury to visual cortex						x
959.01	Head Injury, unspecified	x		x			
907.0	Late effect of intracranial injury without mention of skull fracture	x					x
New V15.52 Codes for Traumatic Brain Injury							
V15.52	History of traumatic brain injury	x					x
V15.52_0	TBI, personal history, NOS-Personal history of traumatic brain injury not otherwise specified	x					x
V15.52_1	TBI, personal history, GWOT, unknown level-Personal history of traumatic brain injury (TBI), Global War on Terrorism (GWOT) related, unknown level of	x					x
V15.52_2	TBI, personal history, GWOT, mild-Personal history of traumatic brain injury, Global War on Terrorism related, highest level of severity mild (glasgow coma scale 13- 15), LOC<1hr, post trauma amnesia<24	x		x			
V15.52_3	TBI, personal history GWOT, moderate-Personal history of traumatic brain injury, Global War on Terrorism related, highest level of severity moderate (glasgow coma scale 9-12), LOC 1-24 hrs, post trauma amnesia 2-7 days	x			x		
V15.52_4	TBI, personal history GWOT, severe-Personal history of traumatic brain injury, Global War on Terrorism related, highest level of severity severe (glasgow coma scale 3-8), LOC>24 hrs, post trauma amnesia >7 days	x				x	
V15.52_5	TBI, personal history GWOT, penetrating-Personal history of traumatic brain injury, Global War of Terrorism related, penetrating intracranial wound (no level of severity assigned)		x				
V15.52_6	TBI, personal history, Non-GWOT, Unknown-Personal history of traumatic brain injury not GWOT related, unknown level of severity	x					x
V15.52_7	TBI, personal history, Non-GWOT, mild-Personal history of traumatic brain injury not related to Global War on Terrorism, highest level of severity mild (glasgow coma scale 13-15) LOC<1 hr, post trauma amnesia<24)	x		x			
V15.52_8	TBI, personal history, Non-GWOT, moderate-Personal history of traumatic brain injury not related to Global War on Terrorism, highest level of severity moderate (glasgow coma scale 9-12), LOC 1-24 hrs, post trauma amnesia 2-7 days	x			x		
V15.52_9	TBI, personal history, Non-GWOT, severe-Personal history of traumatic brain injury not related to Global War on Terrorism, highest level of severity severe (glasgow coma scale 3-8), LOC>24 hrs, post trauma amnesia>7 days	x				x	
V15.52_A	TBI, personal history, Non-GWOT penetrating-Personal history of traumatic brain injury not related to Global War on Terrorism, penetrating intracranial wound (no level of severity assigned)		x				
V15.52_B	TBI, personal history, unknown if GWOT, unknown-Personal history of traumatic brain injury unknown if GWOT related, unknown severity level	x					x

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
V15.52_C	TBI, personal history, unknown if GWOT, mild-Personal history of traumatic brain injury, unknown if related to Global War on Terrorism, highest level of severity mild (glasgow coma scale 13-15), LOC 1<hr, post trauma amnesia<24	x		x			
V15.52_D	TBI, personal history, unknown if GWOT moderate-Personal history of traumatic brain injury, unknown if related to Global War on Terrorism, highest level of severity moderate (glasgow coma scale 9-12), LOC 1-24 hrs, post trauma amnesia 2-7 days	x			x		
V15.52_E	TBI, personal history, un if GWOT severe-Personal history of traumatic brain injury, unknown if related to Global War on Terrorism, highest level of severity severe (glasgow coma scale 3-8), LOC>24 hrs, post trauma amnesia>7 days	x				x	
V15.52_F	TBI, personal history, unknown if GWOT penetrating-Personal history of traumatic brain injury, unknown if related to Global War on Terrorism, penetrating intracranial wound (no level of severity assigned)		x				
V15.5+ext							
V15.5_1	Personal history of TBI, Global War On Terrorism (GWOT) Related, Unknown level of severity						x
V15.5_2	Personal history of TBI, GWOT Related, Mild (Glasgow Coma Scale 13-15),LOC<1hr, Post Trauma Amnesia <24 hrs	x		x			
V15.5_3	Personal history of TBI ,GWOT Related, Moderate (Glasgow Coma Scale 9-12),LOC 1-24 hrs Post Trauma Amnesia 1-6 days	x			x		
V15.5_4	Personal history of TBI, GWOT Related, Severe (Glasgow Coma Scale 3-8),LOC >24 hrs, Post Trauma Amnesia >6 days	x				x	
V15.5_5	Personal history of TBI, GWOT Related, Penetrating Intracranial Wound		x				
V15.5_6	Personal history of TBI, Not GWOT Related, Unknown level of severity						x
V15.5_7	Personal history of TBI, Not GWOT Related, Mild (Glasgow Coma Scale 13-15),LOC<1 hr Post Trauma Amnesia <24 hrs	x		x			
V15.5_8	Personal history of TBI, Not GWOT Related, Moderate (Glasgow Coma Scale 9-12),LOC 1-24 hrs Post Trauma Amnesia 1-6 days	x			x		
V15.5_9	Personal history of TBI, Not GWOT Related, Severe (Glasgow Coma Scale 3-8),LOC >24 hrs, Post Trauma Amnesia >6 days	x				x	
V15.5_A	Personal history of TBI, Not GWOT Related, Penetrating Intracranial Wound		x				
V15.5_B	Personal history of TBI, Unknown if GWOT Related, Unknown level of severity						x
V15.5_C	Personal history of, Unknown if GWOT Related, Mild (Glasgow Coma Scale 13-15),LOC<1 hr, Post Trauma Amnesia <24 hrs	x		x			
V15.5_D	Personal history of Unknown if GWOT Related, Moderate (Glasgow Coma Scale 9-12),LOC 1-24 hrs, Post Trauma Amnesia 1-6 days	x			x		
V15.5_E	Personal history of TBI, Unknown if GWOT Related, Severe (Glasgow Coma Scale 3-8),LOC >24 hrs, Post Trauma Amnesia >6 days	x				x	

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ICD-9-CM		DVBIC TBI Severity Classifications					
Codes	Definition	Closed	Penetrating	Mild	Moderate	Severe	Unclassified
V15.5_F	Personal history of TBI, Unknown if GWOT Related, Penetrating Intracranial Wound		x				
Revised Personal History of TBI, Global War on Terrorism (GWOT) V-codes							
V15.59+ext							
V15.59_1	Personal history of TBI, Global War On Terrorism (GWOT) Related, Unknown level of severity						x
V15.59_2	Personal history of TBI, GWOT Related, Mild (Glasgow Coma Scale 13-15), LOC<1hr, Post Trauma Amnesia <24 hrs	x		x			
V15.59_3	Personal history of TBI, GWOT Related, Moderate (Glasgow Coma Scale 9- 12), LOC 1-24 hrs, Post trauma amnesia 1-6 days	x			x		
V15.59_4	Personal history of TBI, GWOT Related, Severe (Glasgow Coma Scale 3-8), LOC >24 hrs, Post Trauma Amnesia >6 days	x				x	
V15.59_5	Personal history of TBI, GWOT Related, Penetrating Intracranial Wound		x				
V15.59_6	Personal history of TBI, Not GWOT Related, Unknown level of severity						x
V15.59_7	Personal history of TBI, Not related to Global War on Terrorism, Mild (Glasgow Coma Scale 13-15), LOC <1Hr, Post trauma <24	x		x			
V15.59_8	Personal history of TBI, Not Related to Global War on Terrorism, (GWOT), Moderate (Glasgow Coma Scale 9-12), LOC 1-24 hrs, Post trauma amnesia 1-6 days	x			x		
V15.59_9	Personal history of TBI, Not Related to GWOT, Severe (Glasgow Coma Scale 3- 8), LOC>24, Post trauma amnesia>6 days	x				x	
V15.59_A	Personal history of TBI, Not Related to GWOT, Penetrating intracranial wound		x				
V15.59_B	Personal history of TBI, Unknown if GWOT Related, Unknown level of severity						x
V15.59_C	Personal history of TBI, Unknown if related to GWOT, Mild (Glasgow Coma Scale 13-15), LOC<1, Post trauma amnesia<24 hr	x		x			
V15.59_D	Personal history of TBI, Unknown if related to GWOT, Moderate (Glasgow Coma Scale 9-12), LOC 1-24 hrs, Post trauma amnesia 1-6 days	x			x		
V15.59_E	Personal history of TBI, Unknown if related to GWOT, Severe (Glasgow Coma Scale 3-8), LOC>24 hrs, Post trauma amnesia>6 days	x				x	
V15.59_F	Personal history of TBI, Unknown if related to GWOT, Penetrating intracranial wound		x				

Source: Defense and Veterans Brain Injury Center

## APPENDIX D

### MODIFIED BARELL MATRIX TO INCLUDE THE DEFENSE AND VETERANS BRAIN INJURY CENTER'S TRAUMATIC BRAIN INJURY ICD-9-CM CODES

				A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
				ICD-9-CM Codes	FRACTURE 800-829	DISLOCATION 830-839	SPRAINS/ STRAINS 840-848	INTERNAL 850-854,860-869 892-895-95	OPEN WOUNDS 870-884, 890- 894	AMPUTATIONS 885-887, 895-897	BLOOD VESSELS 900-904	CONTUSION/ SUPERFICIAL 910-924	CRUSH 925-929	BURNS 940-949	NERVES 950-951 953-957	UNSPECIFIED 959	SYSTEMWIDE & LATE EFFECTS 967.0	POST- CONCUSSION 310.2
Head and Neck	Traumatic Brain Injury (TBI)	1	Type 1 TBI	800.801,803.804(1-4, 6-9),(03-05, 53-55) 850(2-4),851-854,950(1-3),955-55	800.801,803.804(1-4, 6-9) 800.801,803.804(03-05, 53-55)	/	/	850(2-4) 851-854*, 955-55	/	/	/	/	/	/	950.1-3	/	/	/
		2	Type 2 TBI	800.801,803.804(00,02,06,09),(50,52,56,59),850(0.1,5,9)	800.801,803.804(00,02,06,09), 800.801,803.804(50,52,56,59)	/	/	850(0.1,5,9)	/	/	/	/	/	/	/	/	/	/
		3	Type 3 TBI	800.801,803.804(01,51)	800.801,803.804(01,51)	/	/	/	/	/	/	/	/	/	/	/	/	/
		4	Additional DV/BIC codes*	310.2,907,0,959.01	/	/	/	/	/	/	/	/	/	/	/	959.01*	907.0	310.2
	Other head, face, neck	5	Other Head	873(0-1, 8-9), 941.x6, 951, 959.01	/	/	/	/	873.0-1, 8-9	/	/	/	/	/	941.x6	951	/	/
		6	Face	802, 830, 848.0-1, 872, 873.2-7, 941(x1,x3-x5, x7)	802	830	848.0-1	/	872, 873.2-7	/	/	/	/	/	941.x1,x3-x5, x7	/	/	/
		7	Eye	870-871, 918, 921, 940, 941.x2, 950(0, 8)	/	/	/	/	870-871	/	/	918, 921	/	/	940, 941.x2	950(0, 8)	/	/
		8	Neck	807.5-6, 848.2, 874, 925.2, 941.x8, 953.0, 954.0	807.5-6	/	848.2	/	874	/	/	/	925.2	/	941.x8	953.0, 954.0	/	/
		9	Head, Face, and Neck Unspecified	900, 910, 920, 925.1, 941.x0, .x8, 947.0, 957.0, 959.09	/	/	/	/	/	/	900	910, 920	925.1	947.x0, .x8, 947.0	957.0	959.09	/	/
Spine and Back	Spinal Cord (SCI)	10	Cervical SCI	806(0-1), 952.0	806.0-1	/	/	952.0	/	/	/	/	/	/	/	/	/	/
		11	Thoracic/Dorsal SCI	806(2-3), 952.1	806.2-3	/	/	952.1	/	/	/	/	/	/	/	/	/	/
		12	Lumbar SCI	806(4-5), 952.2	806.4-5	/	/	952.2	/	/	/	/	/	/	/	/	/	/
		13	Sacrum Coccyx SCI	806(6-7), 952(3-4)	806.6-7	/	/	952.3-4	/	/	/	/	/	/	/	/	/	/
		14	Spine + Back unspecified SCI	806(8-9), 952(8-9)	806.8-9	/	/	952.8-9	/	/	/	/	/	/	/	/	/	/
	Vertebral Column (VCI)	15	Cervical VCI	805(0-1), 839(0-1), 847.0	805.0-1	839.0-1	847.0	/	/	/	/	/	/	/	/	/	/	/
		16	Thoracic/Dorsal VCI	805(2-3), 839(2-3), 847.1	805.2-3	839.2-3	847.1	/	/	/	/	/	/	/	/	/	/	/
		17	Lumbar VCI	805(4-5), 839(20, 30), 847.2	805.4-5	839.20, 30	847.2	/	/	/	/	/	/	/	/	/	/	/
		18	Sacrum Coccyx VCI	805(6-7), 839(41-42), 839(51-52), 847.3-4	805.6-7	839(41-42, 51-52)	847.3-4	/	/	/	/	/	/	/	/	/	/	/
		19	Spine + Back unspecified VCI	805(8-9), 839(40, 49), 839(50, 59)	805.8-9	839(40, 49, 50, 59)	/	/	/	/	/	/	/	/	/	/	/	/
Torso	Torso	20	Chest (thorax)	807(0-4), 839(61, 71), 848(3-4), 860-862, 875, 879(0-1), 901, 922(0-1, 33), 928.19, 942.x1-x2, 953.1	807.0-4	839.61, 71	848.3-4	860-862	875, 879.0-1	/	901	922(0, 1, 33)	928.19	942.x1-x2	953.1	/	/	/
		21	Abdomen	863-866, 868, 879(2-5), 922(0, 4), 922.2, 942.x3, 947.3, 953.2, 9	/	/	/	863-866, 868	879.2-5	/	902.0-4	922.2	/	942.x3, 947.3	953.2, 953.5	/	/	/
		22	Pelvis & Urogenital	808, 839(69, 79), 846, 848.5, 867, 877-878, 902(5, 81-82), 922.4, 928(0, 12), 942.x5, 947.4, 953.3	808	839.69, 79	846, 848.5	867	877-878	/	902 (5, 81-82)	922.4	928(0, 12)	942.x5, 947.4	953.3	/	/	/
		23	Trunk	809, 879(6-7), 911, 922(8-9), 926(8-9), 942(x0,x8), 954(1, 8-9), 959.1	809	/	/	/	879.6-7	/	/	911, 922.8-9	926.8-9	942.x0, 942.x9	954.1, 8-9	959.1	/	/
		24	Back and Buttock	847.3, 876, 922(31-32), 926.11, 942.x4	/	/	847.9	/	876	/	/	922.31-32	926.11	942.x4	/	/	/	/
Extremities	Upper	25	Shoulder & Upper Arm	810-812, 831, 840, 880, 887(2-3), 912, 923.0, 927.0, 943(x3-x6), 959.2	810-812	831	840	/	880	887.2-3	/	912, 923.0	927.0	943.x3-x6	/	959.2	/	/
		26	Forearm, Elbow	813, 832, 841, 881(x0-x1), 887(0-1), 923.1, 927.1, 943(x1-x2)	813	832	841	/	881.x0-x1	887.0-1	/	923.1	927.1	943.x1-x2	/	/	/	/
		27	Wrist, Hand, & Fingers	814-817, 833-834, 842, 881.x2, 882, 883, 885-886, 914-915, 923(2-3), 927(2-3), 944, 959(4-5)	814-817	833, 834	842	/	881.x2, 882, 883	885-886	/	914-915, 923.2-3	927.2-3	944	/	959.4-5	/	/
		28	Other & unspecified	818, 884, 887(4-7), 903, 913, 923(8-9), 927(8-9), 943(x0, x9), 953.4, 955, 959.3	818	/	/	/	884	887.4-7	903	913, 923.8-9	927.8-9	943.x0, x9	953.4, 955	959.3	/	/
		29	Hip	820, 835, 843, 924.01, 928.01	820	835	843	/	/	/	/	924.01	928.01	/	/	/	/	/
	Lower	30	Upper leg & thigh	821, 887(2-3), 924.00, 928.00, 945.x6	821	/	/	/	887.2-3	/	/	924.00	928.00	945.x6	/	/	/	/
		31	Knee	822, 836, 844.0-3, 924.11, 928.11, 945.x0	822	836	844.0-3	/	/	/	/	924.11	928.11	945.x0	/	/	/	/
		32	Lower leg & ankle	823-824, 837, 845.0, 897(0-1), 924(10, 21), 928(10, 21), 945(x3-x4)	823-824	837	845.0	/	/	897.0-1	/	924.10, 21	928.10, 21	945.x3-x4	/	/	/	/
		33	Foot & toes	825-826, 838, 845, 1, 852-853, 895-896, 917, 924(3, 20), 929(3, 20), 945(x1-x2)	825-826	838	845.1	/	892-893	895-896	/	917, 924.3, 20	928.3, 20	945.x1-x2	/	/	/	/
		34	Other & unspecified	827, 844(8-9), 890-891, 894, 897(4-7), 904(0-8), 916, 924(4-5), 928(8-9), 945(x0,x9), 959.6-7	827	/	844.8, 9	/	890-891, 894	897.4-7	904.0-8	916, 924.4-5	928.6-8	945.x0, x9	/	959.6-7	/	/
Unclassified by Site	Other & unspecified	35	Other/multiple	819, 828, 902(87, 89), 947(1-2), 953.8, 956	819, 828	/	/	/	/	/	/	902.87, 89	/	/	947.1-2	953.8, 956	/	/
		36	Unspecified site	829, 839(8-9), 848(8-9), 869, 879(8-9), 902.9, 904.9, 919, 924(8, 9), 929, 946, 947(8, 9), 948, 949, 953.8, 957(1, 8-9), 959(8, 9)	829	839.8-9	848.8-9	869	879(8-9)	/	902.9, 904.9	919, 924.8, 9	929	946, 947.8, 9, 948, 949	953.8, 957.1, 8-9	959.8, 9	/	/
	System-wide & late effects	37	System-wide & late effects	905-908, 909 (0, 1, 2, 4, 9), 930-939, 958, 960-964, 995.50-54, 59, 995(80-85)	Foreign body (930-939), Early complications of trauma (958), Poisoning (960-979), Toxic Effects (980-989), Other and unspecified effects of external cause (990-994) Child and adult maltreatment (995.50-54, 59, 995.80-85) Late effects of injuries, poisonings, toxic effects and other external causes (955-959) excluding 909(3, 5)													

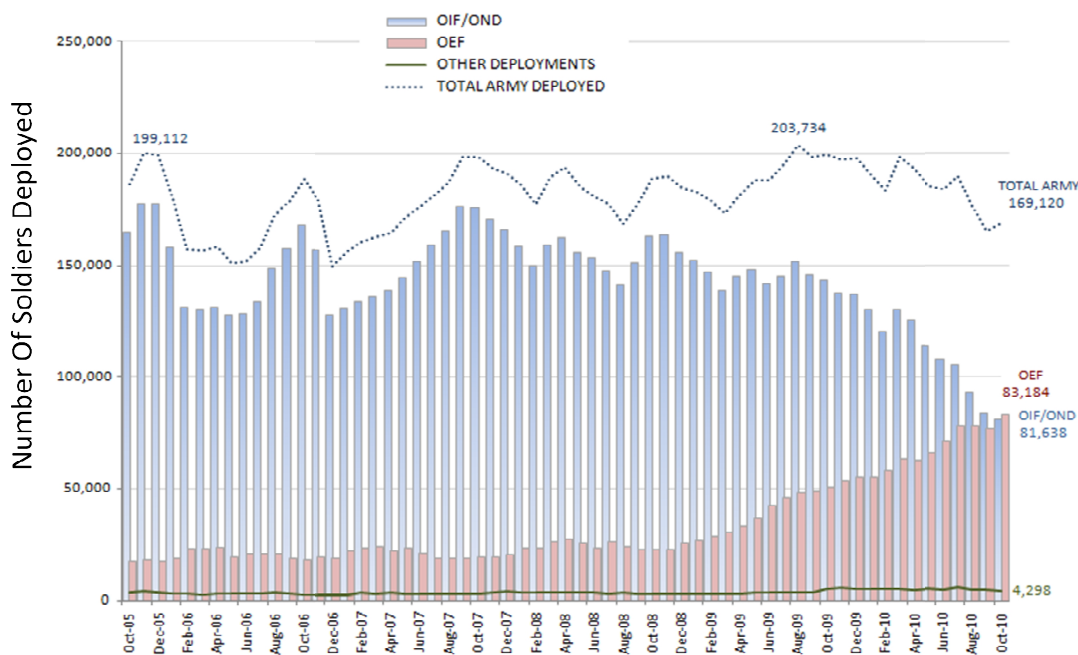
Special diagnostic codes for trauma: Flail Chest (807.4) Pneumothorax (860)

For purposes of classification, head injuries are labeled as Type 1 TBI if there is recorded evidence of an intracranial injury or a moderate or a prolonged loss of consciousness (LOC), Shaken Infant Syndrome (SIS), or injuries to the optic nerve pathways. Type 2 TBI includes injuries with no recorded evidence of intracranial injury, and LOC of less than one hour, or LOC of unknown duration, or unspecified level of consciousness. Type 3 TBI includes patients with no evidence of intracranial injury and no LOC.

\* Note from CDC: 959.01 (added to ICD-9-CM in 1997) is not intended to be assigned to TBI cases; however, in the USA it has been assigned incorrectly to a substantial proportion of cases previously coded 854.

APPENDIX E

ARMY SOLDIERS DEPLOYED BY MONTH FOR  
OVERSEAS CONTINGENCY OPERATIONS



Prepared by Dr. Michael J. Carino, Plans, Analysis, and Evaluation, Office of the Surgeon General  
Data source: Defense Manpower Data Center, 31 October 2010

## APPENDIX F

### ANNUAL RATES FOR WOUNDED IN ACTION, FATAL BATTLE INJURIES, AND FATAL NON-BATTLE INJURIES IN OPERATIONS IRAQI FREEDOM (OIF) AND ENDURING FREEDOM (OEF), 2004-2009 (ARMY)<sup>1</sup>

Operation	Year	Wounded in Action		Fatal Battle Injuries		Fatal Non-Battle Injuries		Incident TBIs	
		n	Rate <sup>2</sup>	n	Rate <sup>2</sup>	n	Rate <sup>2</sup>	n	Rate <sup>2</sup>
OIF	2004	4,492	310.8	415	28.7	95	6.6	424	29.3
	2005	4,076	318.1	476	37.1	116	9.1	538	42.0
	2006	3,980	359.4	472	42.6	76	6.9	510	46.1
	2007	4,923	400.9	646	52.6	110	9.0	1129	91.9
	2008	1,792	148.8	193	16.0	73	6.1	492	40.8
	2009	586	51.8	68	6.0	58	5.1	258	22.8
	Overall	19,849	268.3	2270	30.7	528	7.1	3351	45.3
OEF	2004	170	128.3	21	15.9	24	18.1	42	31.7
	2005	209	136.8	50	32.7	25	16.4	36	23.6
	2006	371	216.9	62	36.2	21	12.3	52	30.4
	2007	695	350.4	78	39.4	28	14.1	148	74.7
	2008	563	254.1	97	43.8	18	8.1	122	55.1
	2009	1517	402.9	195	51.8	23	6.1	431	114.5
	Overall	43,223	499.7	5043	58.3	1195	13.8	7533	87.1

Note:

<sup>1</sup>Data source Defense Manpower Data Center (<http://siadapp.dmdc.osd.mil/>; accessed 30 Dec 2011)

<sup>2</sup>Rate: injuries per 10,000 deployed p-years

- For OIF, trends for the annual rates of wounded in action and fatal battle injuries are similar to the trends reported for traumatic brain injury (Figures 2-7). Rates increased from 2004 to 2007 and then decreased from 2008 and 2009.
- For OEF, the trends for the annual rate of wounded in action and fatal battle injuries are similar to the trends reported for traumatic brain injury (Figures 2-7). Generally, the TBI rates increased from 2006 through 2009, with the greatest increase being in 2009.